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**COMPREHENSIVE EVALUATION OF GROUNDWATER RESOURCES
IN THE REGINA AREA**

by

H. Maathuis and G. van der Kamp

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HIGHLIGHTS

In the Regina area groundwater has been used since the end of the nineteenth century for domestic and industrial water supply. Until 1955 it was practically the only source of water for the City of Regina.

During recent decades the total groundwater pumping rate has averaged about ten million cubic metres of water per year (10,000 dam³ or 8100 acre-feet per year), about one-third of the total water usage by the city. The recharge rate and the available reserves are large enough that this rate of pumping can be maintained on a sustained yield basis. Groundwater therefore is an important and reliable water resource for the Regina area.

Water levels in the Boggy Creek, Mallory Springs and Mound Springs well fields have been stable for many years. These well fields appear to be operating at a near-maximum rate of withdrawal and the potential for well field expansion is therefore minimal.

Groundwater levels in the Regina Aquifer (roughly the Regina urban-industrial area) have dropped by about 5 to 6 metres between 1940 and 1980. The water level decline has slowed in recent years and the aquifer appears to be used on a sustained yield basis at present.

Contamination is of major concern with regard to long-term groundwater use in the Regina area. The sands and gravels of the Condie Moraine are especially vulnerable to contamination. Rigorous monitoring of the water quality from production wells is necessary because the extent and movement of the contaminated water cannot be reliably predicted.

Effective management and protection of the groundwater resources can only be done on a regional basis, taking into account the interaction of groundwater and surface water.

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1. INTRODUCTION

1.1 Previous Studies

Historically, groundwater has constituted an important source of water for the City of Regina since the turn of the century. In fact, from 1883 to 1955 when the surface water supply from Buffalo Pound Lake started, water from wells was practically the sole source of water for the City. At present about 30 percent of Regina's water consumption is derived from wells.

In view of the importance of groundwater for Regina it is not surprising that the groundwater resources of the Regina area have been the subject of numerous studies of both regional and local nature (see Section 12, References). Chief among the earlier studies were those of Wynne-Roberts (1912), Hill, Wynne-Roberts and Simpson (1930) and Lissey (1962). In response to the continuous need for a better understanding of groundwater in the Regina area, the Saskatchewan Research Council further refined the occurrence and behavior of groundwater in the area, culminating in reports by Meneley and Christiansen (1975) and Schneider (1978). Van der Kamp and Maathuis (1985) compiled and reviewed all available geological and groundwater data and, in an interim report, provided an updated evaluation of the groundwater resources in the Regina area.

1.2 Present Report

New data which have become available since the report by van der Kamp and Maathuis (1985) played a significant role in refining the geological and hydrogeological framework of the Regina area and in further updating the evaluation of the groundwater resources in this

area. The comprehensive evaluation of the groundwater resources presented in this report provides the basis for establishing a groundwater management plan for the Regina area.

The geological and hydrogeological setting of the Regina area is discussed in detail in Chapter 2. The extent, continuity and discontinuity of aquifer zones is shown in the text in the form of simplified maps. Detailed maps and cross sections are presented in a separate report (Maathuis and van der Kamp, 1988a) which supplements this report.

In Chapter 3, the type of groundwater data used in the preparation of this report are reviewed. Water quality and water level data are presented in the report in the form of tables and figures. These data are also shown on maps and cross sections provided by Maathuis and van der Kamp (1988a). Data on yearly withdrawals are included in the report as tables.

The groundwater resources of individual aquifers are described in detail in Chapters 4 to 8. Aspects related to management and protection of these resources are discussed in Chapter 9. Recommendations for further investigations are provided in Chapter 10.

1.3 Study Area

For the purpose of the present study, the Regina area has been divided as the area enclosed by the 50 15' North Latitude and 104 and 105 West Longitude. This area (see Figure 1.3-1) roughly corresponds to the area covered by Ranges 15 to 22, Townships 15 to 21, West of the Second meridian.

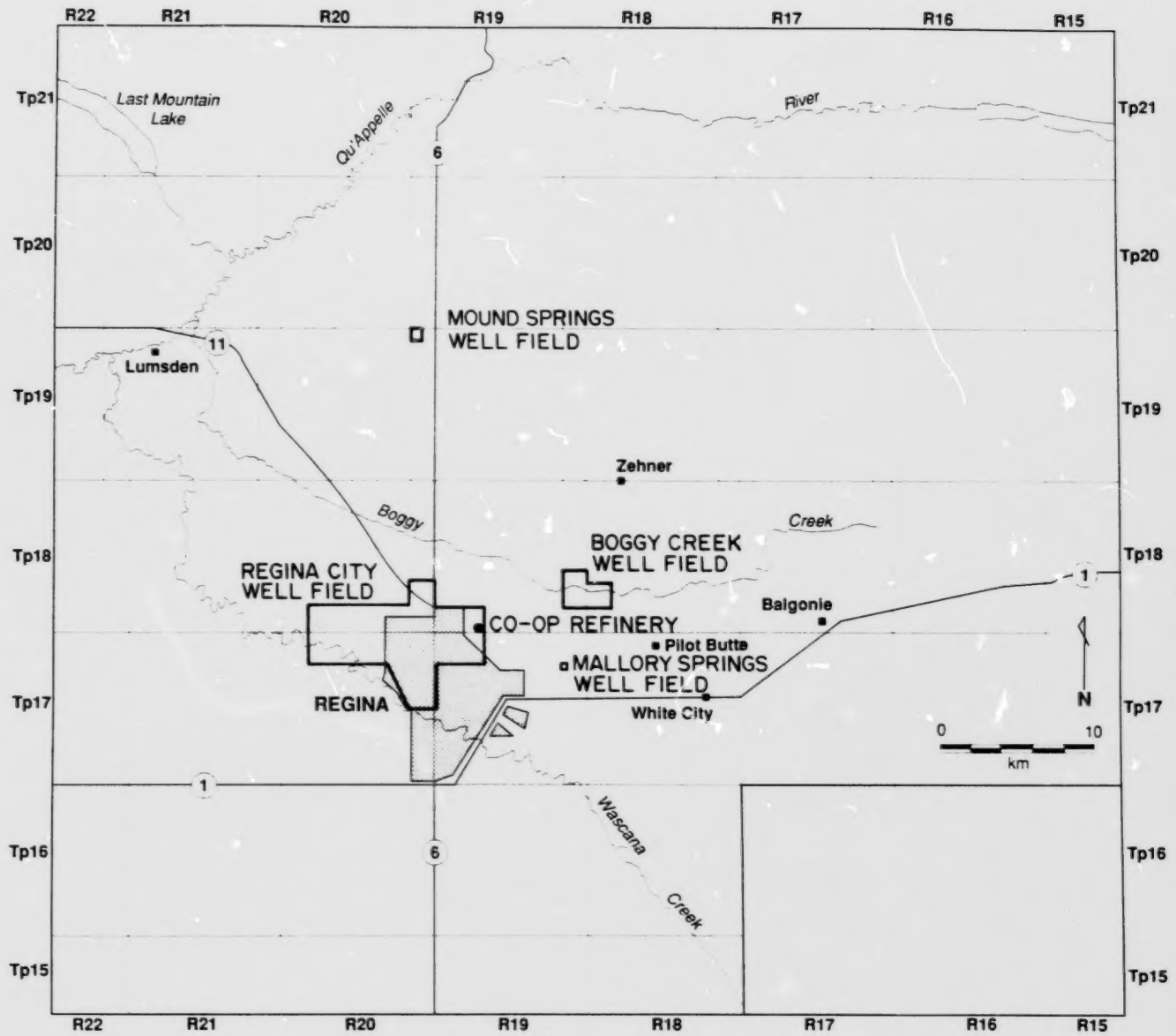


Figure 1.3-1 Extent of study area and location of well fields

Climatic data of the study area have been provided by Environment Canada (1982) and by New grade Energy (1985b, page 3-2). The mean annual precipitation at Regina airport is 384.0 mm, 70 percent of which falls as rain and 30 percent as snow. The topographical setting of the area is available in the form of 1:250,000 and 1:50,000 topographical maps and is not further discussed.

1.4 History of Groundwater Development and Use

Due to the City's location, far away from any major body of surface water, groundwater has played a vital role in the development of Regina. Groundwater constituted practically the sole source of water for the City from its founding until 1955, when surface water from Buffalo Pound Lake first became available.

The first well in the City area was drilled in April 1883, within a year of the City's founding. This well, drilled at the corner of Broad Street and South Railway Street, struck a good supply of water at 97 feet (Regina Leader, April 26, 1883). The well appears to have drawn its water from the Interglacial Sediments portion of the Regina Aquifer.

In the following 20 years other wells were constructed in various parts of the City to supply the needs of the local neighborhoods. These early water wells are all now abandoned.

In 1904 the first system of waterworks was constructed (Ball, 1978). It was intended to use surface water from the reservoir on Boggy Creek, which was created by construction of a dam in NW7-18-18-W2. During construction of the pipeline to the reservoir, a strong flow of groundwater into the trench was encountered in Section 1 of 18-19-W2.

This flow was sufficient to meet the needs of the City for several years. In fact, it appears that water was never actually pumped from the Boggy Creek reservoir itself. The flow of groundwater into the first pipeline was used to augment the total water supply until at least 1959 (flow from 10-inch line, see Appendix C).

From 1911 on production wells were drilled in the area around the Boggy Creek reservoir, following the recommendations of Wynne-Roberts (1912). The earliest wells were frequently abandoned and replaced, but over the years since 1911 the Boggy Creek well field (see Figure 1.3-1) has constituted the largest single source of groundwater for the City.

By 1929 the water needs of the City were exceeding the supply from the Boggy Creek well field. The report by Hill et al (1930) reviewed various possibilities for surface-water and groundwater schemes. Development of well fields at Mallory Springs and Mound Springs were recommended (see Figure 1.3-1). This was done and production from wells at Mallory Springs started in 1930 while production from Mound Springs well field apparently started in 1935.

In the meanwhile numerous wells had been drilled in the City area, mostly by various industries, with the Imperial Oil Refinery being the single largest user. The City of Regina was also drawing water from two wells in the City area.

During the period from 1935 to 1959 no major expansions of the groundwater supply were undertaken, but a few additional production wells were completed in the main well fields. After 1955 the demand was increasingly met by surface water supply piped from Buffalo Pound Lake.

From 1959 to 1962 a major hydrogeological study of the area was carried out (Lissey, 1962). A number of new production wells were completed, including major expansion of the Regina City well field (see Figure 1.3-1) to the north-west, along 9th Avenue.

After 1962 groundwater use has remained more or less steady over the years, although the yearly production has varied considerably, ranging from a low of 4130 cubic decametres in 1971 to a high of 14,147 cubic decametres in 1980. The variation in groundwater use mainly reflects the availability of surface water from Buffalo Pound Lake and the year-to-year variation in demand.

From time to time new production wells have been completed to replace or augment older wells, but no major well field expansions have been carried out since 1962. The capacity of the Boggy Creek well field has been increased recently by means of shallow wells, drawing water by infiltration from a gravel pit (Beckie Hydrogeologists Ltd. ,1986a).

The average annual production of water for the ten years from 1978 to 1987 can be summarized as follows:

(a) Groundwater

Boggy Creek Well Field	4,380 dam ³
Mallory Springs Well Field	510 dam ³
Mound Springs Well Field	1,920 dam ³
Regina City Well Field	3,290 dam ³
Licensed Private Wells	<u>1,220 dam³</u>
Total Groundwater	11,320 dam ³

(b) Surface Water

Buffalo Pound Lake	20,510 dam ³
--------------------	-------------------------

These data show that about one-third of the City's water needs are met by groundwater. This proportion will probably decline over the years as production from Buffalo Pound Lake is increased.

Groundwater is now mostly being used to meet peak demands during the summer and/or as a reserve to augment the surface-water supply at times of reduced pumping capacity from the Lake. As such the groundwater supply is of significant value to the City of Regina because replacing it by extra surface water capacity would require expensive treatment facilities, pipelines and storage facilities.

The groundwater production from licensed private wells is dominated by the Consumers Co-operative Refinery which pumps an average of 1,003 dam³ from its wells. In addition, there are numerous non-licensed private wells, predominantly for domestic use only, scattered throughout the area. Concentrations of such wells occur in the Towns of Pilot Butte and White City. The Town of Balgonie pumps about 210 dam³ from its production well. Details of production of groundwater are given in Appendix C of this report, and in a report on water demand by Stanley Associates (1988).

In recent years a major concern and expenditure with regard to the groundwater supply has been in relation to potential contamination. Investigations of potential contamination have been carried out and are on-going at a number of sites. As long as groundwater is used by the City, there can be no doubt that groundwater contamination will be an important issue.

2. GEOLOGY AND HYDROGEOLOGICAL SETTING

2.1 Introduction

The geological setting of the Regina area was discussed and shown in the form of cross sections and maps by Christiansen (1961, 1971, 1979a, 1979c), Lissey (1962), Meneley and Christiansen (1975), and Schneider (1975). The history of glaciation and deglaciation has been described by Christiansen (1961, 1979a,b). The surficial geology has been discussed by Christiansen (1961, 1979a). Maps showing the surficial geology have been presented by Christiansen (1961), Mollard and Associates Ltd. for Saskatchewan Urban Affairs (1979), and the Saskatchewan Research Council (1985). Soils in the study area have been described by Ellis et al (1965). The history of glaciation and deglaciation, the surficial geology and soils are not further discussed in this report.

The present report is based on the geological framework of the Regina area as established and discussed by Christiansen (1979a).

The geological setting of the Regina area, the stratigraphical units and their lithological characteristics, and the hydrogeological setting, are illustrated schematically in Figure 2.1-1.

The geological framework, from a hydrogeological point of view, is shown in the form of 17 cross sections, included in the separate report (Maathuis and van der Kamp, 1988a) which supplements this report.

The cross section lines have been chosen such that they not only would provide the regional geological setting but also the more detailed geological setting in areas of particular concern. For example, a large number of cross sections were constructed in the area east of the Bogy

STRATIGRAPHY		LITHOLOGY	HYDROGEOLOGY	
SASKATOON GROUP	Surficial Stratified Drift	Clay and Silt	Aquitard	
	Condie Moraine	till silt sand, gravel,	aquitard aquifer	
	Battleford Formation	Till	Aquitard	
	FLORAL FORMATION	Upper Till	Till	Aquitard
		Upper Sand and Gravel	Sand, Gravel Till, and Silt	Aquifer
		Interglacial Sediments	silts	Aquitard
			silts, sands and gravels	Aquifer
		Lower Till	Till	Aquitard
	Lower Sand and Gravel	sand and gravel	Aquifer	
	SUTHERLAND GROUP	Upper Till	Till	Aquitard
Lower Till		not present		
EMPRESS GROUP		silt sand and gravel	Aquifer Aquitard	
BEDROCK SURFACE				
BEARPAW FORMATION		Silt and Clay	Aquitard	
ARDKENNETH MEMBER		Silt and Clay	Aquifer	
BEARPAW FORMATION		Silt and Clay	Aquitard	

Figure 2.1-1 Schematic geological and hydrogeological setting of the Regina area (Stratigraphy after Christiansen, 1979).

Creek well field to investigate the continuity of the aquifers in which wells of this well field were completed. Two special cross sections were constructed (see Maathuis and van der Kamp, 1988a): cross section F - F' is a longitudinal cross section through the Condie aquifer and cross section H - H' is a southwest- northeast section through the City of Regina.

2.2 Bedrock stratigraphy

The bedrock stratigraphy within the study area was discussed by Christiansen (1961, 1971, 1979a, 1979c). The Bearpaw Formation is the single most important bedrock unit in the study area since it forms the bedrock surface throughout the area. The Cretaceous Bearpaw Formation consists of marine, gray, non-calcareous silts and clays. Locally it also may include the Ardkeneth Member: a sand interbed consisting of fine-grained sands and silts. The Ardkeneth Member could be considered an aquifer but its occurrence appears to be largely limited to the Regina collapse structure. Within the area of the collapse structure it forms isolated aquifer zones (for example, see Maathuis and van der Kamp, 1988a: cross section H - H'). Consequently, within the framework of the present study, this unit is not further discussed. The silts and clays of the Bearpaw Formation may reach a thickness of 244 metres (Van der Kamp and Maathuis, 1985). Since these silts and clay probably have a low vertical hydraulic conductivity, the top of the Bearpaw Formation can be considered as the impermeable lower boundary as far as the groundwater flow systems above it are concerned.

The bedrock surface topography is shown in Figure 2.2-1 and in

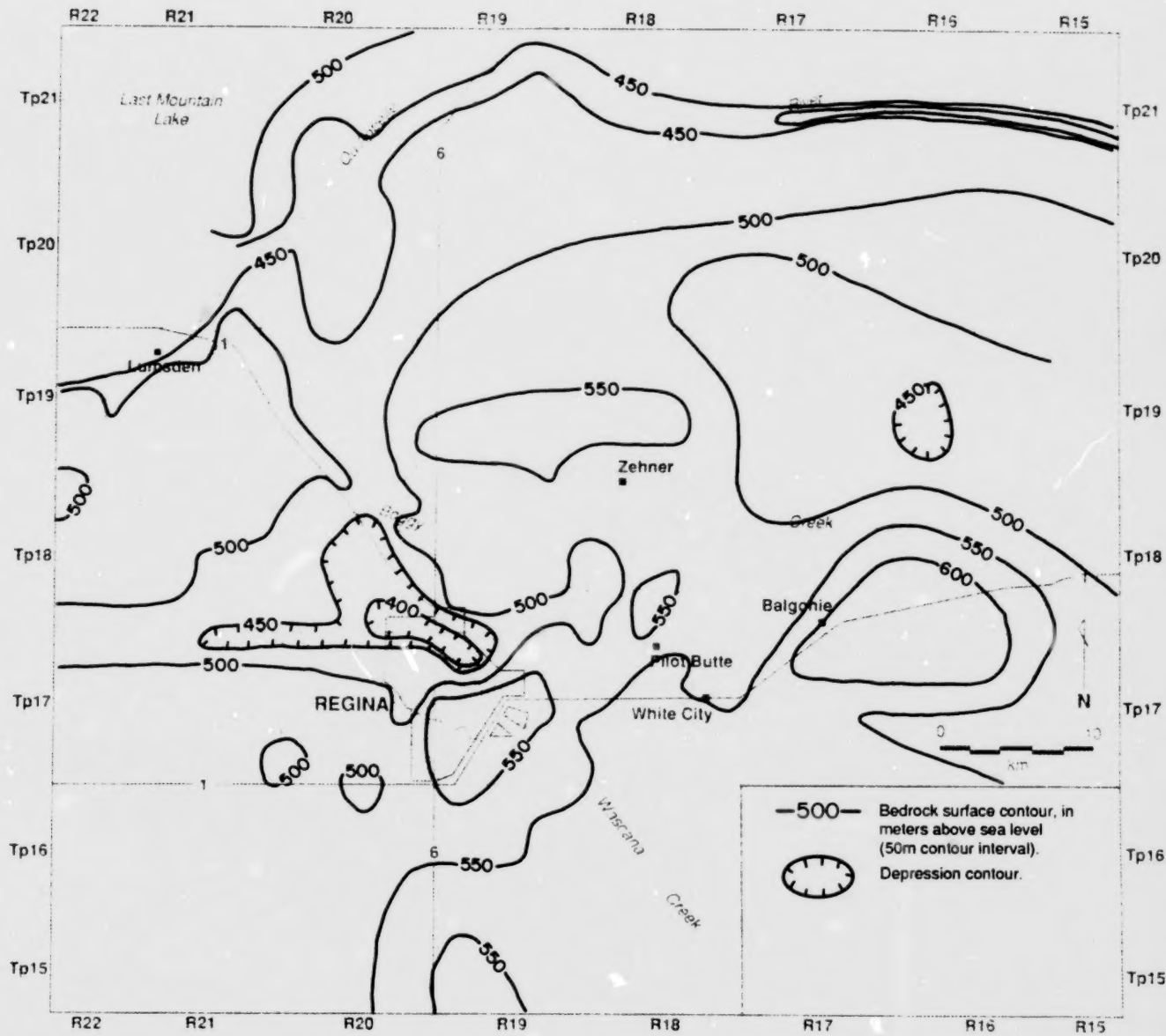


Figure 2.2-1 Bedrock surface topography

more detail on Map No. 1 (Maathuis and van der Kamp, 1988a). The main bedrock topography features are: a large depression beneath and in the vicinity of Regina, due to collapse; a bedrock "high" just east of the Boggy Creek well field area; and two major depressions, probably due to glacial erosion, in the northern half of the study area. It should be noted that the configuration of the bedrock surface topography, in particular in the northern and eastern portions of the study area, is somewhat uncertain because there are only a few testholes in these areas penetrating the bedrock.

2.3 Quaternary Stratigraphy

The Quaternary stratigraphy, in ascending order, may include the Empress, Sutherland and Saskatoon Groups (see Figure 2.1-1). A brief description of these units is given below.

2.3.1 Empress Group

The Empress Group is composed of sand, gravel, silt and clay of fluvial, lacustrine and colluvial origin that overlies the Cretaceous bedrock and non-marine Tertiary bedrock, and underlies till of Quaternary age in southern Saskatchewan (Whitaker and Christiansen, 1972).

Christiansen (1979a) indicates that the Empress Group in the study area can be subdivided into areas where it mainly consists of silts and where it mainly is composed of sand and gravel. Consequently, locally it may form an aquifer and elsewhere an aquitard. Only in Range 21, Township 20 are farm wells known to have been completed in sand and

gravels of the Empress Group (see Maathuis and van der Kamp, 1988a: cross section K - K', logs 7 to 227). Unnamed aquifers formed by sediments of the Empress Group also occur within the area of the collapse structure (see Maathuis and van der Kamp, 1988a: for example, cross section E - E'). An unnamed Empress Group aquifer may also occur beneath the Boggy Creek well field area (see Maathuis and van der Kamp, 1988a: section D - D, log 76). However, these aquifers appear to be of limited extent. Since not much is known about these aquifers, both in terms of water level and water quality, they are discussed only briefly in this report. It is unlikely that these aquifers constitute a significant and reliable water supply source for Regina.

2.3.2 Sutherland Group

In the study area the Sutherland Group (Christiansen, 1968a) is composed of zero to 64 metres of till and minor amounts of stratified drift. Christiansen (1979a) indicates that in the area only the Upper Till of the Sutherland Group is present. The Sutherland Group can be distinguished from the Saskatoon Group since the tills of the Sutherland Group have a lower electrical resistance and are less calcareous (see electric logs and carbonate curves on the testhole logs in cross sections). From a hydrogeological point of view, the till of the Sutherland Group forms an aquitard.

2.3.3 Saskatoon Group

In the study area the Saskatoon Group, in ascending order, may include the Floral and Battleford Formations, the Condie Moraine, and

Surficial Stratified Drift.

The Saskatoon Group and the Floral and Battleford Formations were formally defined by Christiansen (1968a,b).

Informally, Christiansen (1979a) has subdivided the Floral Formation, in ascending order, into:

- Lower Floral Sand and Gravel
- Lower Till
- Interglacial Sediments
- Upper Floral Sand and Gravel
- Upper Till

In a study of the geological setting at the Federal Pioneer site Christiansen (1979c) uses a slightly different subdivision of the Floral Formation. In that study, which is of a local nature, Christiansen further subdivides the Interglacial Sediments, in ascending order, into: Lower Glacial Sands and Gravels; Interglacial Silt, Sand and Gravel; and Interglacial Silt. However, in the present study the subdivision of the Floral Formation as used by Christiansen (1979a) has been used since it can be applied on a regional scale.

The following is a brief description of these units and is mainly based on more detailed descriptions provided by Christiansen (1979a):

"The Lower Floral Sand and Gravel lies between the Sutherland Group and the Lower Till of the Floral Formation. This unit is composed of sand and gravel with interbeds of silt and till.

The Lower Till of the Floral Formation lies between the Lower Floral Sand and Gravel and Interglacial Sediments or between the Lower and Upper Floral Sand and Gravel. Where the Lower Floral Sand and Gravel is missing beneath the Interglacial Sediments, the Lower Till lies between the Sutherland Group and these Interglacial Sediments.

The Interglacial Sediments lie between the Lower and Upper Floral Till or between the Lower Till and Upper Floral Sand and Gravel. This unit is composed of fossiliferous, carbonaceous, silt and sand and gravel. Its occurrence is limited to the collapse structure.

The Upper Floral Sand and Gravel lies between the Interglacial Sediments and the Upper Till. This unit is composed of sand and gravel and may include interbedded silt and till. The Upper Floral Till lies between the Interglacial Sediments or Upper Floral Sand and Gravel and the Battleford Formation.

The Battleford Formation is composed of mainly soft, unjointed, and unstained till and generally is less than 1.5 metres thick".

From a hydrogeological point of view, the Battleford and Floral tills and silts of the Interglacial Sediments form aquitards. The Upper and Lower Floral Sand and Gravel, and sands and gravels of the Interglacial Sediments form aquifers.

The Condie and Davin Moraines were first named and described by Christiansen (1961). Christiansen (1979a,c) combines the Condie and Davin Moraines into one morphostratigraphic unit, referred to as the Condie Moraine, and provides the following description:

"The Condie Moraine consists of a core of sand and gravel flanked to the south by an apron of sand and silt. The apron is composed of a lower wedge of sand and an upper blanket of silt, both of which become progressively thinner and finer grained to the south. Most of the Condie Moraine is covered by zero to 7 metres of till deposited presumably by a slight re-advance of the glacier. After the glacier retreated, the Moraine was covered by Lake Regina silt and clay".

Informally, Christiansen (1979a,c) refers to the sands and gravels, and silts, as the Condie Sands and Gravels and Condie Silt, respectively. Hydrogeologically, the Condie Sands and Gravels form an aquifer whereas the Condie Silt is an aquitard.

The most important Surficial Stratified Drift deposit in the study area is the Regina Clay. The Regina Clay was first named and described by Christiansen (1961). Clays and silts of the Regina Clay were deposited into Lake Regina during the final deglaciation of the area. The Regina Clay sediments form an aquitard.

2.4 Collapse Structures

The existence of collapse structures in Saskatchewan has been documented by Christiansen (1967), Christiansen (1971b) and Gendzwill and Hajnal (1971). Christiansen (1979a,c) documents the existence of a major collapse structure in the near vicinity and beneath the City of Regina. As is shown in cross sections E - E', H - H' and I - I' (Maathuis and van der Kamp, 1988a), the bedrock and Empress and Sutherland Groups are clearly collapsed and the Interglacial Sediments fill the depression. The collapse is considered to be due to removal of salt from the Devonian Elk Point, Prairie Evaporite Formation, occurring at a depth of about 1000 m below ground surface.

Testhole information which has become available since 1979 suggests that the collapse structure (see Maathuis and van der Kamp, 1988a: Map No.1) might be much more extensive than previously was assumed (Christiansen, 1979a, Drawing 0016-003-01). For example, carbonaceous silts, probably of interglacial origin, were encountered in testholes 61 and 65 (Maathuis and van der Kamp, 1988a: cross section D - D').

Christiansen (1979a, c) indicates that the centre of the collapse is located beneath the City of Regina, in the area of testhole 175 (see Maathuis and van der Kamp, 1988a: cross section H - H'). However,

whether or not there is one large collapse structure or several, more or less individual, structures can not be determined and is also a question beyond the scope of this report. Christiansen (1979c) indicates that the collapse beneath the City of Regina was initiated before glacial time and continued until the deposition of the Upper Floral Till. Christiansen (1979c) also provides a model for the evolution of the collapse structure beneath the City.

2.5 Identification of Principal Aquifer Zones and Aquitards

Based on the geological setting the following aquifer zones, in descending order can be distinguished (see Figure 2.1-1):

- an aquifer formed by Condie Sands and Gravels.
- aquifers formed by Upper Floral Sands and Gravels.
- aquifers formed by the Interglacial Sediments.
- aquifers formed by Lower Floral Sands and Gravels.
- aquifers formed by sediments of the Empress Group.
- aquifers formed by the Ardkenneth Member.

The aquifer zones are discussed in more detail in the following Sections. Maps have been prepared showing the extent, depth to and thickness of the different aquifer zones, except for the Empress Group and the Ardkenneth Member (Maathuis and van der Kamp, 1988a: Maps 2, 3, 5 and 6).

Aquitards are formed by the silts and clays of the Regina Clay, Condie Silt, and tills of the Saskatoon and Sutherland Groups and silts and clays of the Bearpaw Formation. A separate map (Maathuis and van der Kamp, 1988a: Map No. 4) has been prepared to show the thickness of

the aquitard separating the Condie Sands and Gravels from the Upper Floral Sands and Gravels.

2.6 Sands and Gravels of the Condie Moraine

Map No. 2 (Maathuis and van der Kamp, 1988a) shows the extent, depth to and thickness of the sands and gravels of the Condie Moraine. The Condie Moraine also includes an apron of silt along its southern flanks. This Condie Silt has not been shown on the map because it does not constitute an aquifer zone. The extent of the Condie Sands and Gravels is also shown in Figure 2.6-1.

The Condie Sands and Gravels form a single continuous aquifer, the Condie Aquifer. The Condie Aquifer is discussed in detail in Chapter 4.

2.7 Sands and Gravels of the Upper Floral Formation

The extent, depth to and thickness of Upper Floral Sand and Gravel is shown on Map No. 3 (Maathuis and van der Kamp, 1988a). The extent is also shown in Figure 2.7-1. The depth at which the Upper Floral Sand and Gravel occurs may range from zero to 65 meters. In the vicinity of the City of Regina, it typically occurs at depth in the 20 to 40 meter range. The thickness of this unit may typically range from 10 to 30 meters.

In this report the emphasis was on delineating the major continuous aquifers formed by the Upper Floral Sand and Gravel. Outside the area of the indicated extent of the Upper Floral Sand and Gravel unit many smaller aquifers formed by these sands and gravels occur. However, due to the lack of reliable stratigraphical information and/or absence of

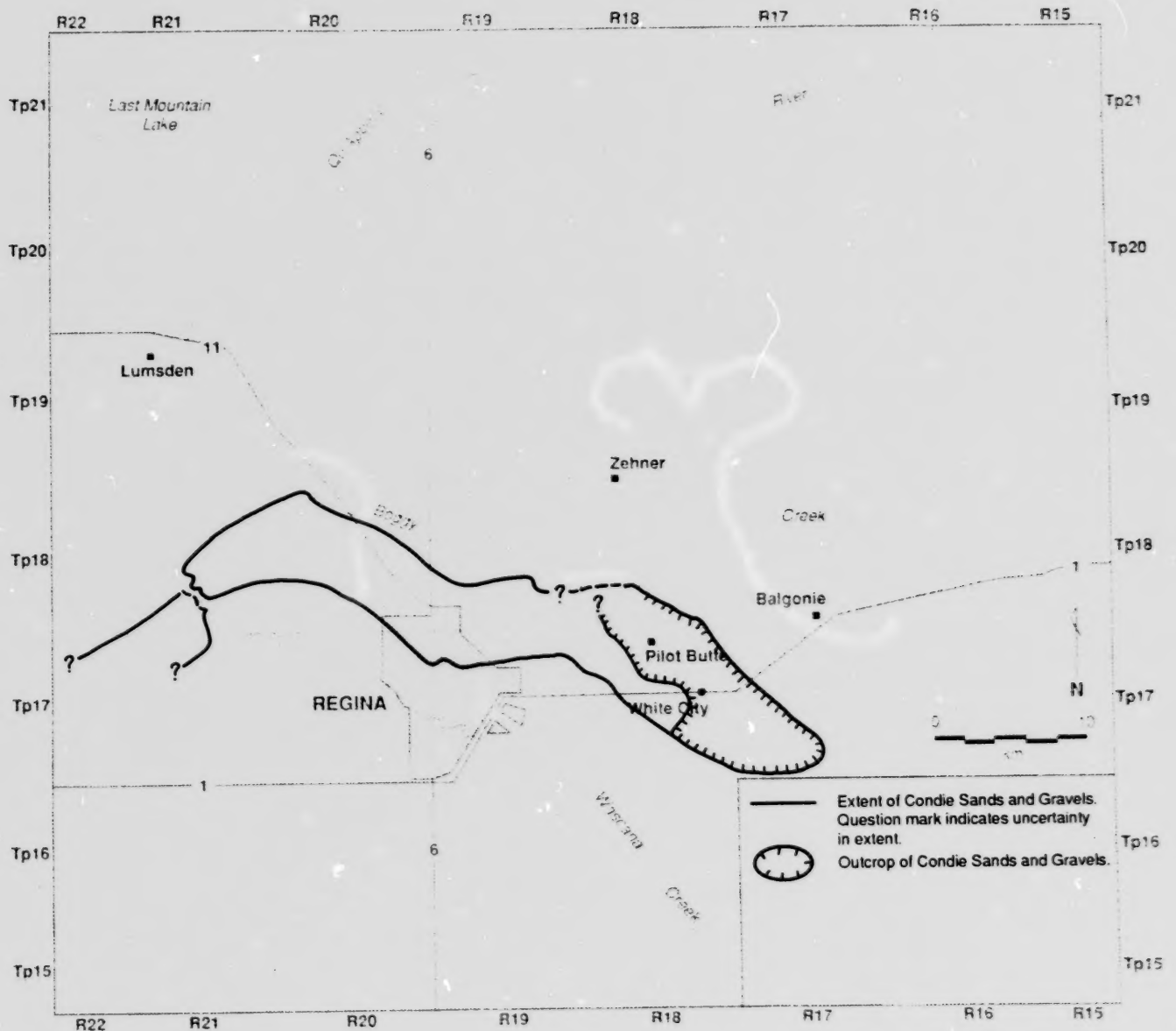


Figure 2.6-1 Extent of Condie Sands and Gravels

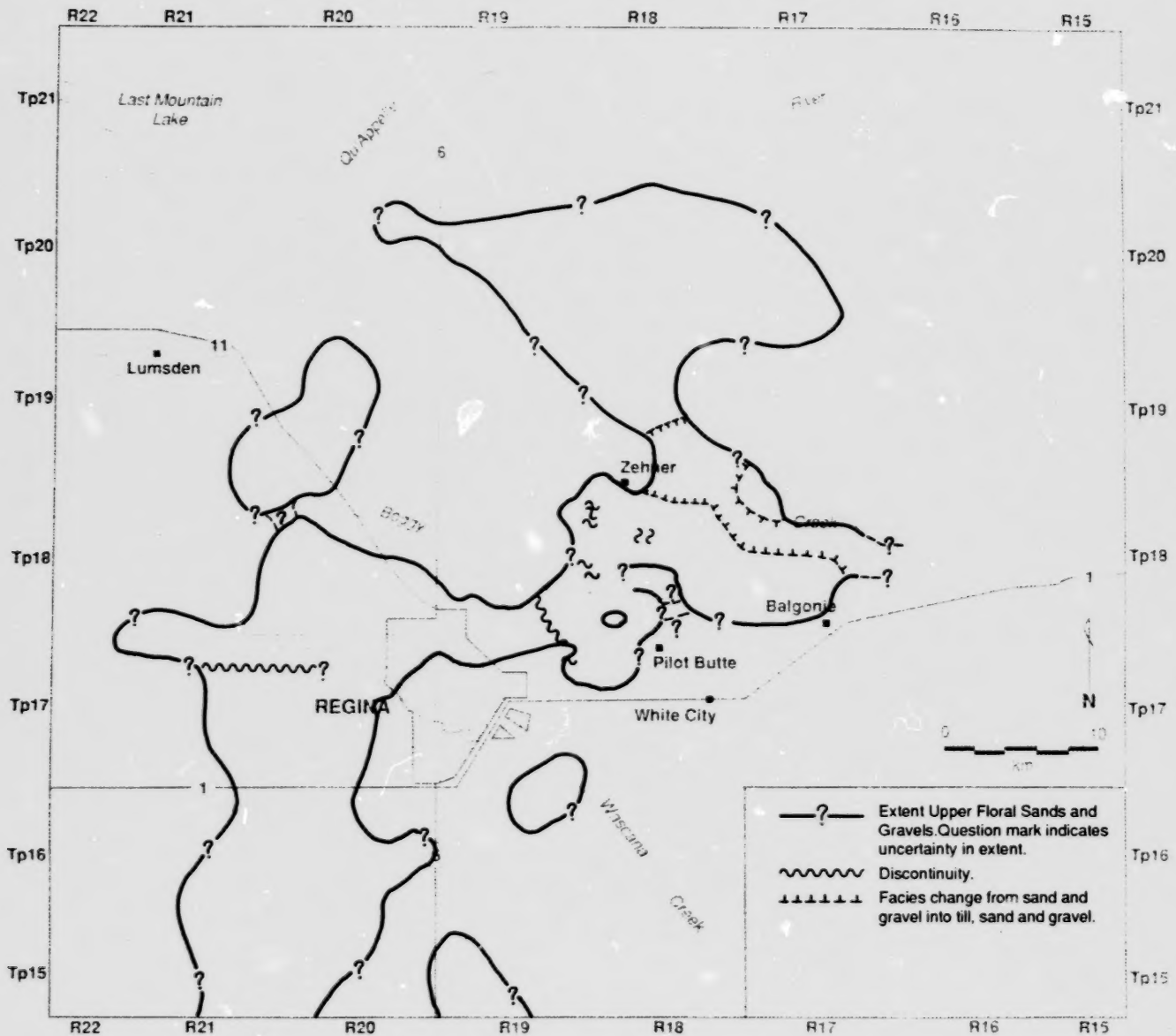


Figure 2.7-1 Extent of Upper Floral Formation Sands and Gravels

testholes, such aquifers cannot be readily identified and delineated. These local aquifers, although of importance for private rural water supplies are of little significance as far as Regina's water supply is concerned.

It should also be noted that, due to the distribution of the available testholes and uncertainty in establishing whether or not a sand or gravel belongs to the Upper Floral sand and gravel unit, the extent as indicated on the map is often uncertain. Where boundaries are particularly uncertain this is indicated on the map by question marks.

Map No. 3 and cross sections (see Maathuis and van der Kamp, 1988a) show that the hydraulic continuity in several areas within the extent of the Upper Floral Sand and Gravel unit is interrupted. These areas are (see Figure 2.7-1):

- the "hydraulic discontinuity" in the southeastern part of Range 19, Township 18, which was identified by van der Kamp and Maathuis (1985).
- the discontinuity, as inferred from cross sections J - J' and K - K', in the northern half of Ranges 20 and 21, Township 17 (see Maathuis and van der Kamp, 1988a).
- discontinuities north and south of the Boggy Creek well field area.

The map and cross sections D - D' and M - M' (Maathuis and van der Kamp, 1988a) also show that major questions continue to exist regarding the extent and continuity of the Upper Floral Sand and Gravel unit within the Boggy Creek well field area itself.

There is some uncertainty as to the continuity and proper identifi-

cation of Upper Floral sands and gravels in the south western part of the map (Ranges 20 and 21, Townships 16 and 17). Cross sections J - J' (logs 199 to 205), K - K' (logs 210 to 214), G - G' (logs 146 to 153) and I - I' (logs 177 - 182) show a continuous Upper Floral Sand and Gravel (see Maathuis and van der Kamp, 1988a). Whether or not the aquifer is indeed as continuous as is shown on these sections is perhaps questionable. It is in particular in this area where there is often insufficient information to establish whether or not a sand or gravel unit belongs to the Upper or Lower Floral Formation Sand and Gravel. Consequently, it cannot be excluded that the geological and hydrogeological setting in this area is more complex than presently is assumed.

The Upper Floral Sands and Gravels north of Balgonie (Range 18, Township 18) form a complex aquifer which has as its unique characteristic that it is dry or virtually dry over a large extent of its occurrence. The "dryness" of this aquifer is indicated by the high resistance of the E-logs. Only in the area immediately north of the Town of Balgonie is its saturated thickness sufficient for well completion. A second characteristic of this aquifer zone is that, both in north and eastward directions, a facies change from sands and gravels into till with sand and gravel layers occurs (Maathuis and van der Kamp, 1988a: cross sections and Map No. 3). The northern boundary of the aquifer zones is probably located near testhole 252 (W2-18-19-15-04-SW).

In the western part of Range 18, Township 18, the westward continuity of the aquifer becomes a complex matter which has not been resolved. As is indicated on Map No. 3, and becomes evident from cross sections C - C', M - M', and N - N', there are many discontinuities in this

area (see Maathuis and van der Kamp, 1988a).

It is evident from Maps No. 1 and 3 and the cross sections that the Boggy Creek well field is located in a collapse structure and that both the geological and hydrogeological setting of this area is extremely complex and still poorly understood.

The following aquifers, in descending order, can be encountered within the well field area:

- a surficial sand and gravel aquifer, the "gravel pits"
- a shallow sand and gravel aquifer covered by till
(see Beckie Hydrogeologists, 1986)
- intertill sand and gravel aquifers, at various depths
(see Maathuis and van der Kamp, 1988a: cross sections D - D' and M - M').
- an aquifer formed by sediments of the Empress Group

Although recently several stratigraphical testholes have been drilled around the well field area, only one stratigraphical testhole has been drilled within it (Maathuis and van der Kamp, 1988a: cross section D - D', log 76). It is evident from the production well completion records (Maathuis and van der Kamp, 1988b) and from the cross sections (Maathuis and van der Kamp, 1988a: cross section D - D', logs 75 - 78; cross section M - M', logs 114 to 246) that production wells have been completed in many different zones. Since no testholes penetrating bedrock have been drilled at the production well sites, and taking the complex setting into account, it is not possible to confidently identify the aquifer zones in which production wells have been completed. It is assumed that both the Upper and Lower Floral Sand and

Gravel units are present at the site. However, it cannot be established whether or not these zones form separate aquifers, one aquifer or a very complex aquifer zone. Pumping and water level records indicate that the aquifer zones, at least to a large degree, are hydraulically connected. Since detailed production well interference tests have not been carried out, the nature and degree of connectivity between the different zones remains unestablished.

2.8 Aquitard Separating the Condie and Upper Floral Sands and Gravels

The continuity and thickness of the till aquitard separating the Condie sands from the underlying Upper Floral sands is of importance with respect to recharge rates and possible contaminant movement. The thickness of this aquitard is therefore shown separately on Map No. 4 (Maathuis and van der Kamp, 1988a). A simplified map of the aquitard thickness is shown in Figure 2.8-1.

In the Boggy Creek well field area the geology is complex and neither the different formations nor the aquitard between them can be identified. There may well be direct hydraulic connection between the Condie and Upper Floral aquifer zones in this area.

Farther west, in Ranges 19, 20 and 21, the aquitard has been encountered in all test holes. Its thickness tends to be less to the west. There may be "gaps" in the aquitard especially farther west, but such gaps have yet been encountered by test drilling.

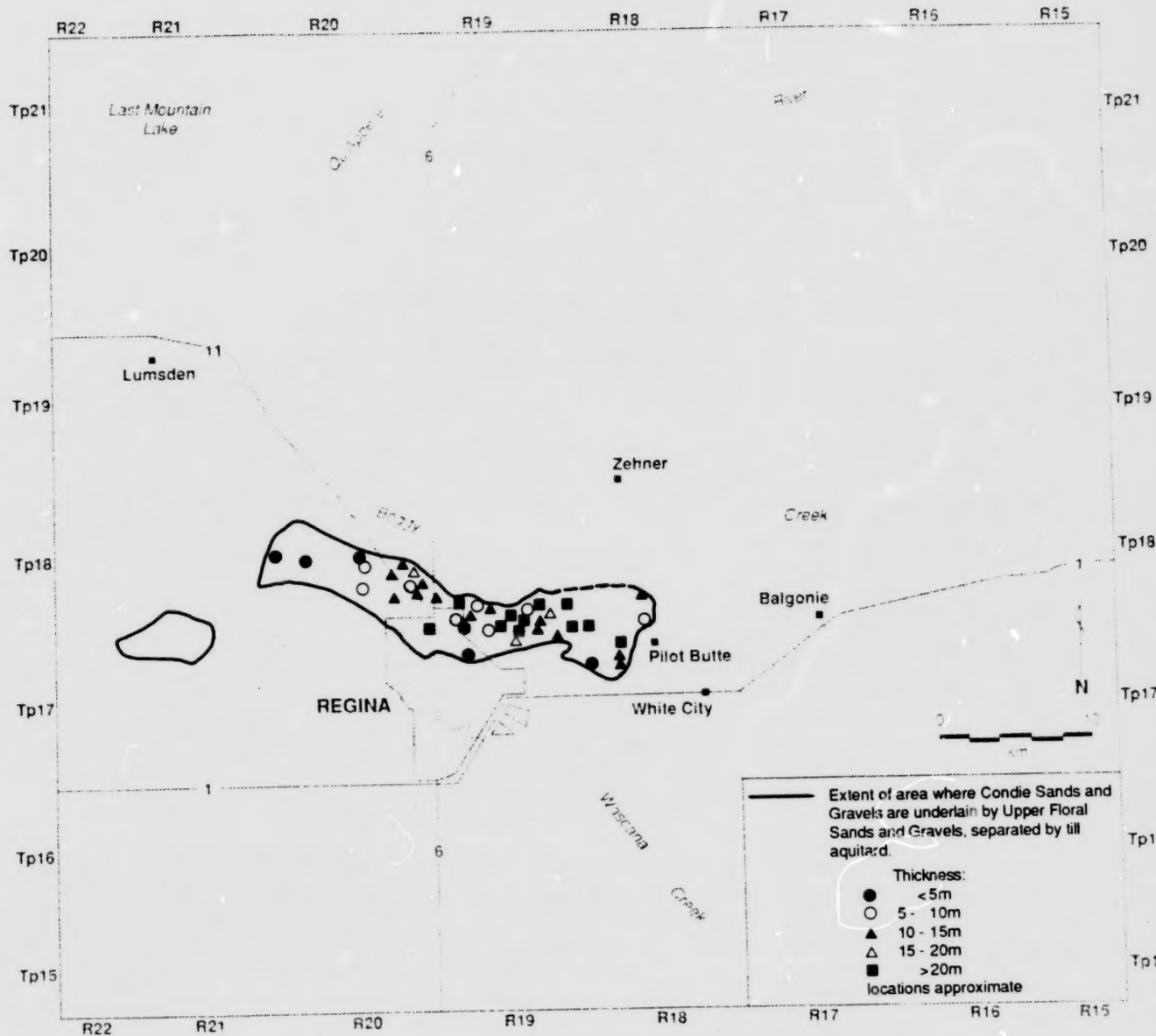


Figure 2.8-1 Thickness of aquitard separating Condrie and Upper Florio Formation Sands and Gravels

2.9 Interglacial Sediments

The extent, depth to and thickness of the Interglacial Sediments are shown on Map No. 5 (Maathuis and van der Kamp). The occurrence of these sediments is limited to the collapse structure within and just west of the city area (see Figure 2.9-1). The continuity of the aquifer zones within these sediments is difficult to assess on geological evidence alone. Due to their limited extent these aquifer zones are not of regional importance, although they have provided water to wells in the city area from its earliest days to the present.

2.10 Sands and Gravels of the Lower Floral Formation

The extent, depth to and thickness of the Lower Floral Formation Sands and Gravels is indicated on Map No. 6 (Maathuis and van der Kamp, 1988a). There are two major occurrences (see Figure 2.10-1): in Range 18, Township 17 and in the northern part of the study area.

The depth below ground surface at which the Lower Floral Formation Sands and Gravels are encountered may range from 12 to 107 metres, depending on the geological setting. Its thickness may range from 2.5 to 21 metres, but typically is in the 5 to 15 metres range.

As was discussed with reference to the Upper Floral sands and gravels, the extent and continuity of both the Upper Floral and Lower Floral Formations in the area of the Boggy Creek well field cannot be established with the presently available data. This area will be discussed further in the later chapter dealing with the Zehner Aquifer System. Outside the area of the indicated extent of the Lower Floral Sand and Gravel unit many smaller aquifers formed by these sands and

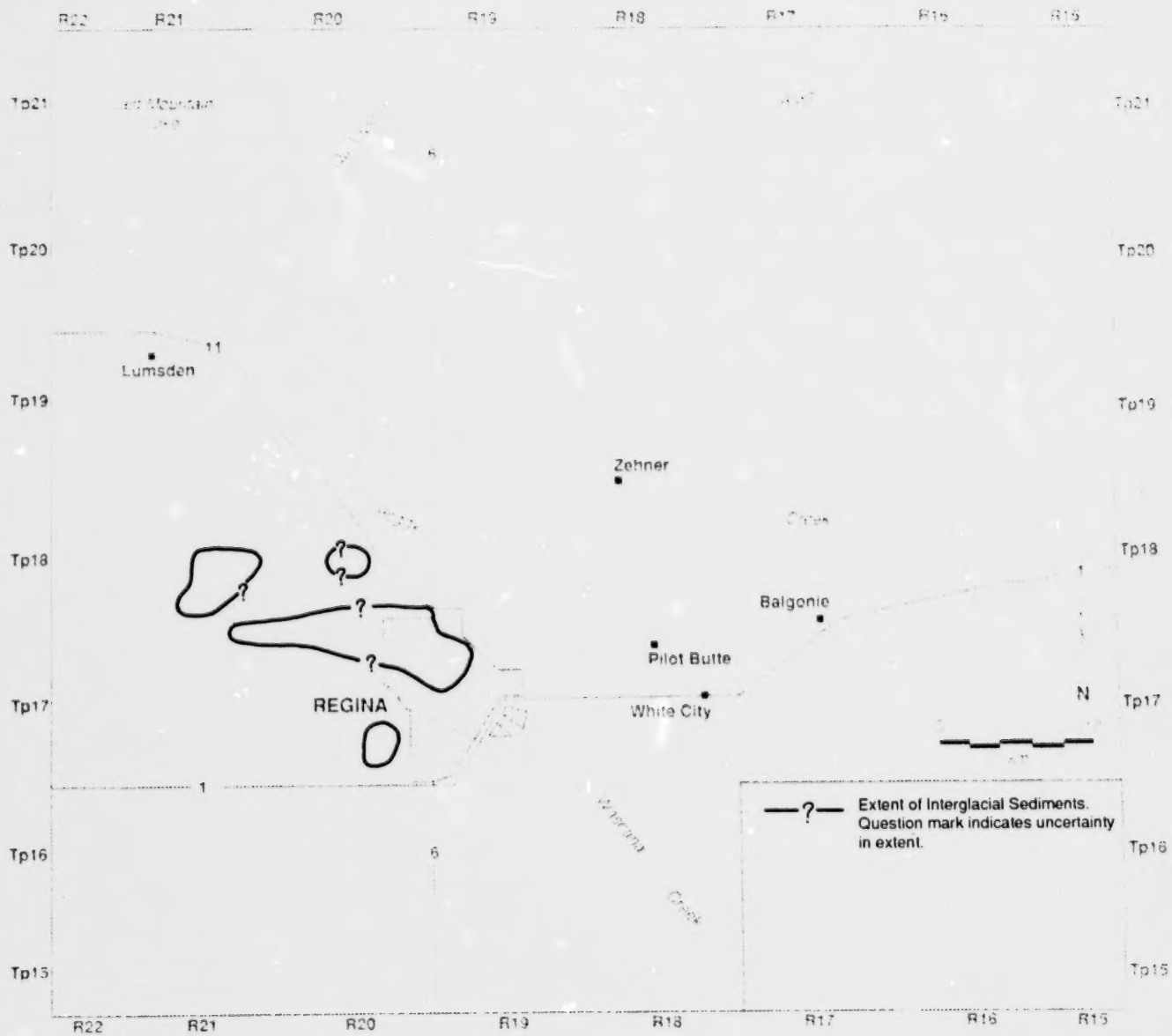


Figure 2.9-1 Extent of Interglacial Sediments

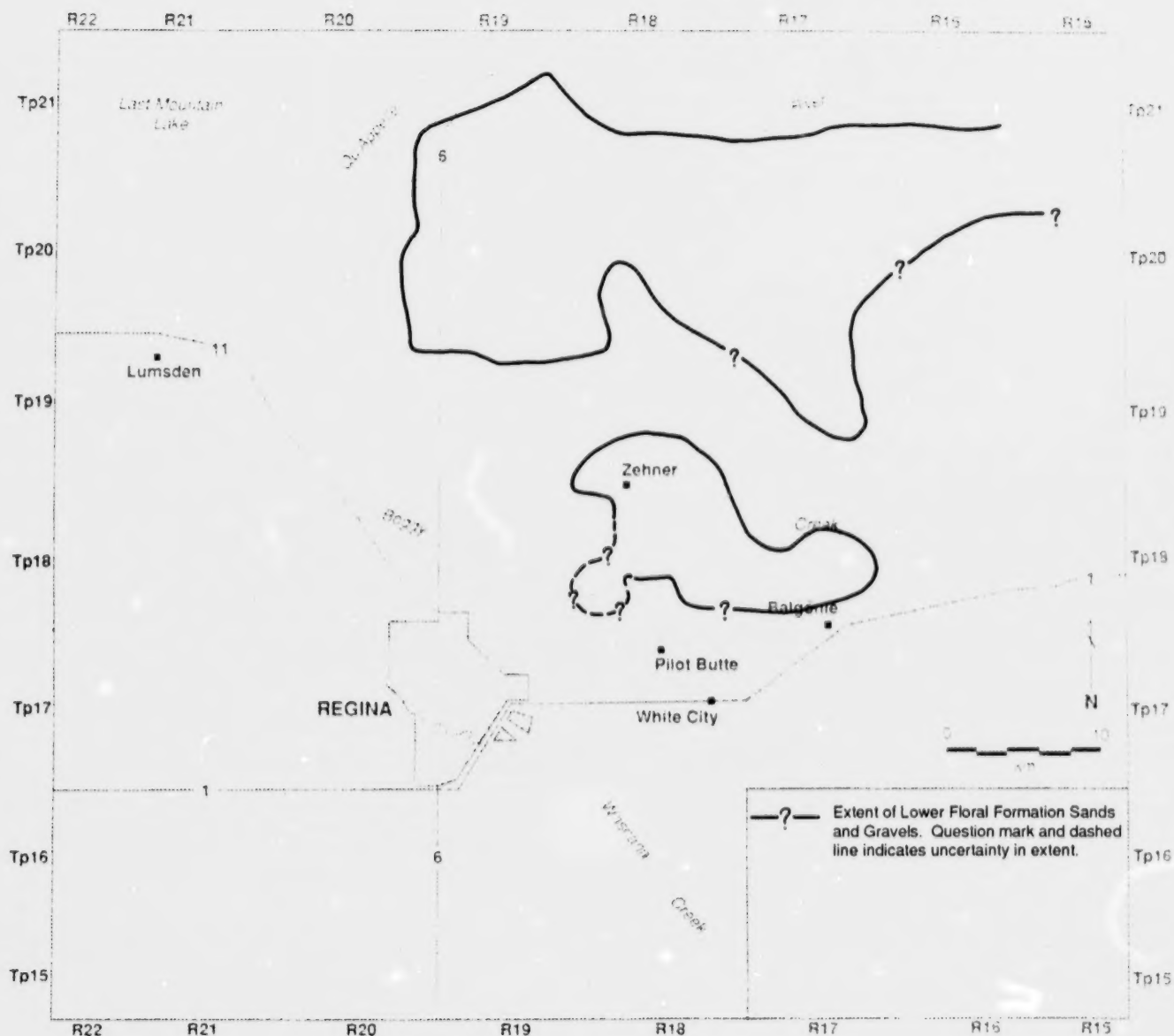


Figure 2.10-1 Extent of Lower Floral Formation Sands and Gravels

gravels occurs. These aquifers cannot be readily identified and delineated because of lack of reliable stratigraphical information and/or absence of testholes. These local aquifers, although of importance for private rural water supplies, are of little significance as far as Regina's water supply is concerned.

2.11 Aquifer Naming

Over the years, a variety of names have been used for various combinations of aquifer zones in the Regina area. As a result there is now some confusion as to what names such as "Regina Aquifer" mean. Much of this confusion has come about because aquifer names were used even though the extent and hydraulic continuity of the aquifer zones were not clearly established.

In the present report naming of aquifers has been avoided if the extent and hydraulic continuity of the aquifer zones in question are substantially uncertain. The naming guidelines suggested by Jorgensen and Signor (1984) have also been used. These authors essentially suggest that geologic-age terminology or stratigraphic terminology should not be used in aquifer names.

3 GROUNDWATER DATA

3.1 Review of Data in Appendices

The principal types of groundwater data used in this report are:

- well location and depth
- static water levels
- groundwater quality
- rate of withdrawals

Data have been collected from many different sources (see References). In addition, SRC has directly obtained data by water sampling, water-level measurements, interviews with owners of wells and field inspections. The groundwater data has been compiled in Appendices A, B, C, and D of this report.

An important question with regard to the groundwater resources in the Regina area concerns possible changes of water levels since groundwater withdrawals started in 1883. Such water level changes or lack thereof have an important bearing on estimates of the long-term yields of various aquifers. An effort has therefore been made to collect and document all available data on groundwater use and static water levels, even when these data are of low reliability, as is particularly the case for much of the earlier data.

Appendix A provides location maps for the production wells, a listing of the production wells and available water quality data for these wells.

In Appendix B an inventory of water level data, arranged according to land location is presented. The source of the information is indicated in the Appendix.

Appendix B also includes water level data gathered in 1987 during three separate measurements of the "instantaneous piezometric surface" of various aquifer units. Water-level data gathered in the course of regular monthly measurements are not included in Appendix B, but are presented and discussed in the text as appropriate.

Yearly groundwater withdrawal data are presented in Appendix C. These data have been compiled from records provided by the City of Regina, by the Saskatchewan Water Corporation, and by the Saskatchewan Archives Board. In particular, all withdrawal data prior to 1960 were compiled from original City of Regina ledgers held by the Archives Board.

A related question concerns the water quality in the different aquifer zones and the changes of groundwater quality that may have occurred since withdrawals and urban-industrial activities started. Data on groundwater quality therefore have been compiled. Analyses with an error in the ionic balance of less than five (5) percent have been tabulated and are presented in Appendix D (Table D-1), arranged according to land location. The sum of ions or total concentration is determined by addition of the concentrations of the following constituents: Ca, Mg, Na, K, Fe, Mn, CO_3 , HCO_3 , SO_4 , Cl, NO_3 , PO_4 , and F. The error in ionic balance, expressed as percentage, is calculated by the equation: $100 \times (\text{sum of anions} - \text{sum of cations}) / (\text{sum of anions} + \text{sum of cations})$. In this equation both the sum of cations and anions are expressed in milliequivalents. Based on the present knowledge, Table D-1 also indicates from which aquifer zone the sample was taken. The groundwater quality data were obtained from the Saskatchewan Research Council's

groundwater quality data base, Rutherford (1966), the City of Regina, and from various consulting reports. The source of the water quality data is also indicated in Table D-1.

The groundwater quality data compiled and presented by Lissey (1962) appeared not to be compatible with the quality of the analyses presented in Table D-1. The data presented by Lissey often lack values for major constituents and calcium and magnesium, bicarbonate and carbonate, were expressed in term of hardness and alkalinities, respectively. However, since these data are of some historical value, a listing of Lissey's most complete analyses is provided in Table D-2, Appendix D.

The past or present occurrence of springs and seeps provide important clues as to rates of recharge and the existence and continuity of aquifer zones. Information pertaining to springs is presented and discussed in the text as appropriate.

3.2 Hydraulic Head and Water Quality Maps

Maps showing selected hydraulic head and water quality data have been prepared for the three stratigraphic units within which the principal aquifer zones occur i.e., the Sand and Gravels of the Condie Moraine, the Upper Floral Formation, and the Lower Floral Formation (Maathuis and van der Kamp, 1988a: Map Nos. 7 to 12).

Very little data is available for the Empress Group and for the Ardkenneth Member. Maps for these units have therefore not been made, but the data are briefly discussed in Chapter 8.

Review and analysis of the hydraulic head and water quality data are left to the following chapters dealing with the major aquifers.

4. GROUNDWATER RESOURCES OF THE CONDIE AQUIFER

4.1 Definition and Extent of Condie Aquifer

Van der Kamp and Maathuis (1985) defined the Condie Aquifer as the aquifer formed by the saturated portion of the sands and gravels of the Condie Moraine from its eastern terminus to Wascana Creek. The Condie Aquifer, in various combinations, is overlain by unsaturated sands of the Condie Moraine, Condie Silt, till of the Battleford Formation and Regina Clay sediments. It is underlain by tills of the Battleford and Floral Formations.

Map No. 2 (Maathuis and van der Kamp, 1988a) shows in detail the extent, depth to and thickness of the Condie Sands and Gravels. It should be noted that the thickness indicated on this map represents the total thickness of the Condie Sands and Gravels and not the saturated thickness. However, since the utmost lower portion of the Condie Sands and Gravels is saturated throughout its extent, Map No. 2 also shows the extent of the Condie Aquifer. The longitudinal section through the centre of the Condie Sands and Gravels (Maathuis and van der Kamp, 1988a: cross section F - F') shows that the Condie Aquifer is a well defined, continuous unit.

To facilitate the discussion of the Condie Aquifer, the Aquifer has been informally subdivided into three sections (Figure 4.1-1). The eastern section is defined as that part of the Condie Aquifer east of Range 19. The central section covers the extent of the Aquifer in Range 19 and eastern half of Range 20. The western section is defined as that part of the Condie Aquifer which occurs west of the middle of Range 20.

Uncertainty exists (Maathuis and van der Kamp, 1988a: Map No. 2) as

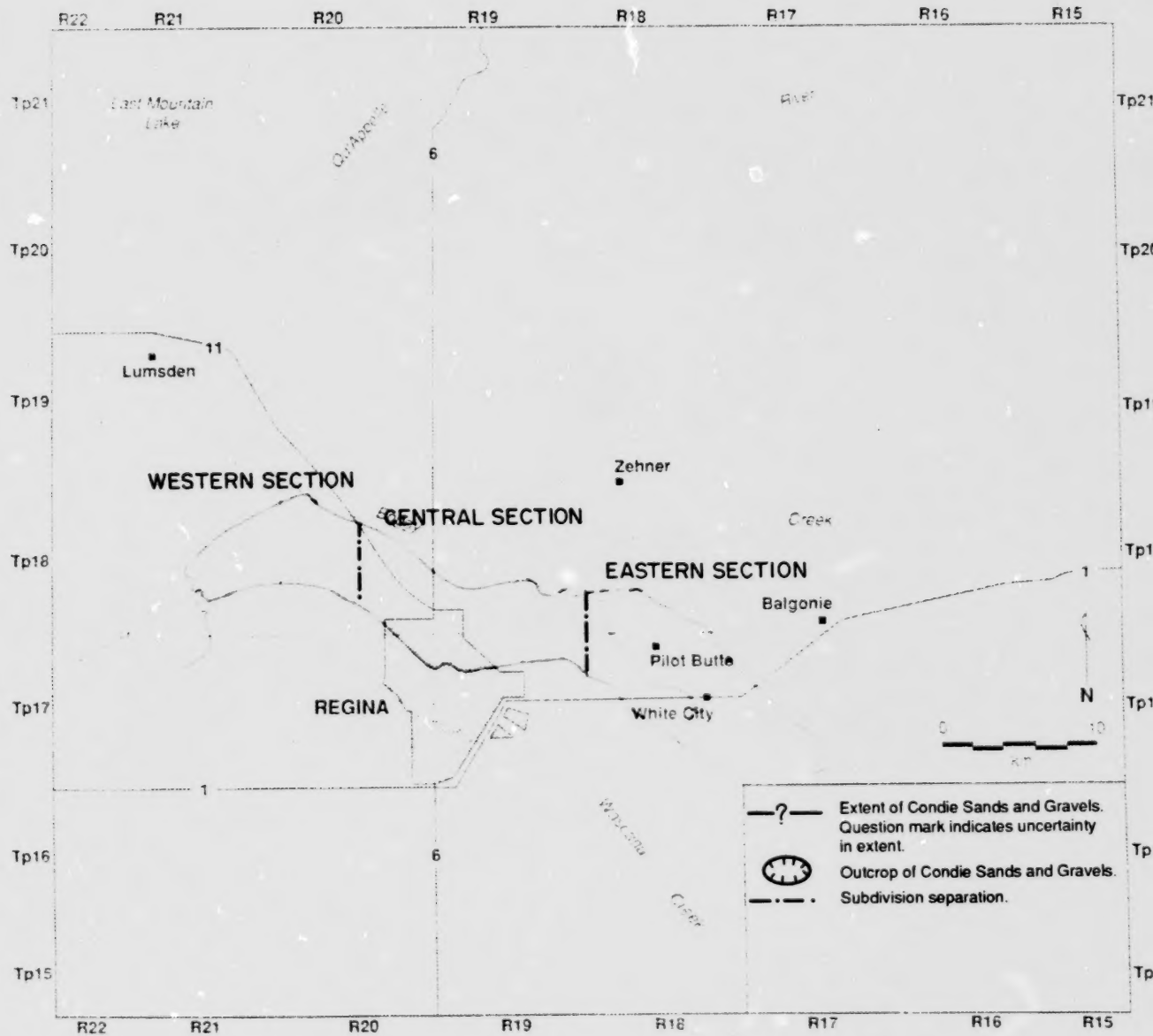


Figure 4.1-1 Extent and subdivision of Condie Aquifer

to the continuity of the Condie Aquifer into the area of the Boggy Creek well field. Cross sections E - E' (logs 112, 113), L - L' (log 239) and M - M' (logs 114, 245, 78) strongly suggest that the Condie Aquifer may occur within the area of the Boggy Creek well field (see Maathuis and van der Kamp, 1988a). However, the relationship between the Condie Aquifer and surficial and near-surficial sands and gravels within the Boggy Creek well field area, can not be determined. This would require a much more detailed and site specific study.

There is a scarcity of data in the area of the Condie Aquifer between Pilot Butte, the Boggy Creek well field, and the City of Regina landfill, and therefore the principal permeable zones of the Condie Aquifer in this area can not be identified. It is uncertain whether the strong westward flow of groundwater in the area of the landfill originates from the Boggy Creek well field area or whether it originates further south in the Pilot Butte area, or both.

4.2 Water Levels in the Condie Aquifer

Water level data for the Condie Aquifer are given in Appendix B and recent data are plotted on Map No. 7 (Maathuis and van der Kamp, 1988a). The data plotted on Map No. 7 include both approximate water levels (unsurveyed datum) and exact levels (surveyed datum) for the period 1977-1987. During this period there were no major changes of water level, as indicated by the relatively constant static water levels in well R2 (W2-20-18-12-NE) since 1960 (see Section 4.4).

From November 1986 on monthly water-level measurements were carried out by the Saskatchewan Water Corporation for piezometers MW29, H21C,

BH86-R2-1, H86-9 and H24B, completed in the Condie Aquifer. The locations of these piezometers are shown in Figure 4.2-1 and the results of the measurements are shown in Figure 4.2-2, together with plots of the barometric pressure at the times of measurement and of the monthly withdrawals from production well R2. The data plotted in Figure 4.2-2 show that the water levels in the central part of the Condie Aquifer are influenced by barometric pressure and by pumping from well R2 (BH86-R2-1 only). It appears that there are very little or no seasonal fluctuations of the water levels in the central and western half of the Condie Aquifer.

For the eastern section (Ranges 17 and 18) of the aquifer, monthly measurements are not available, but it is likely that seasonal fluctuations do occur because the aquifer is shallow and without a confining layer. However, measurements taken for three piezometers near Pilot Butte, as part of the "instantaneous piezometric surface" program, indicate little seasonal fluctuation (TH 85-1, TH 85-5, TH 85-6, see Appendix B). The new observation well, SWC Regina 3 (Beckie, 1987), installed just north-east of Pilot Butte, will provide better data as to water-level fluctuations.

The water-level data obtained in the course of the "instantaneous piezometric surface" program (April 14, August 8 and November 23, 1987) provide a detailed view of the piezometric surface for much of the aquifer. The data for November 23, 1987 are plotted on Map No. 7 (Maathuis and van der Kamp, 1988a), together with a selection of data points obtained from other sources (as listed in Appendix B).

Approximate hydraulic head contours can be sketched for most of the

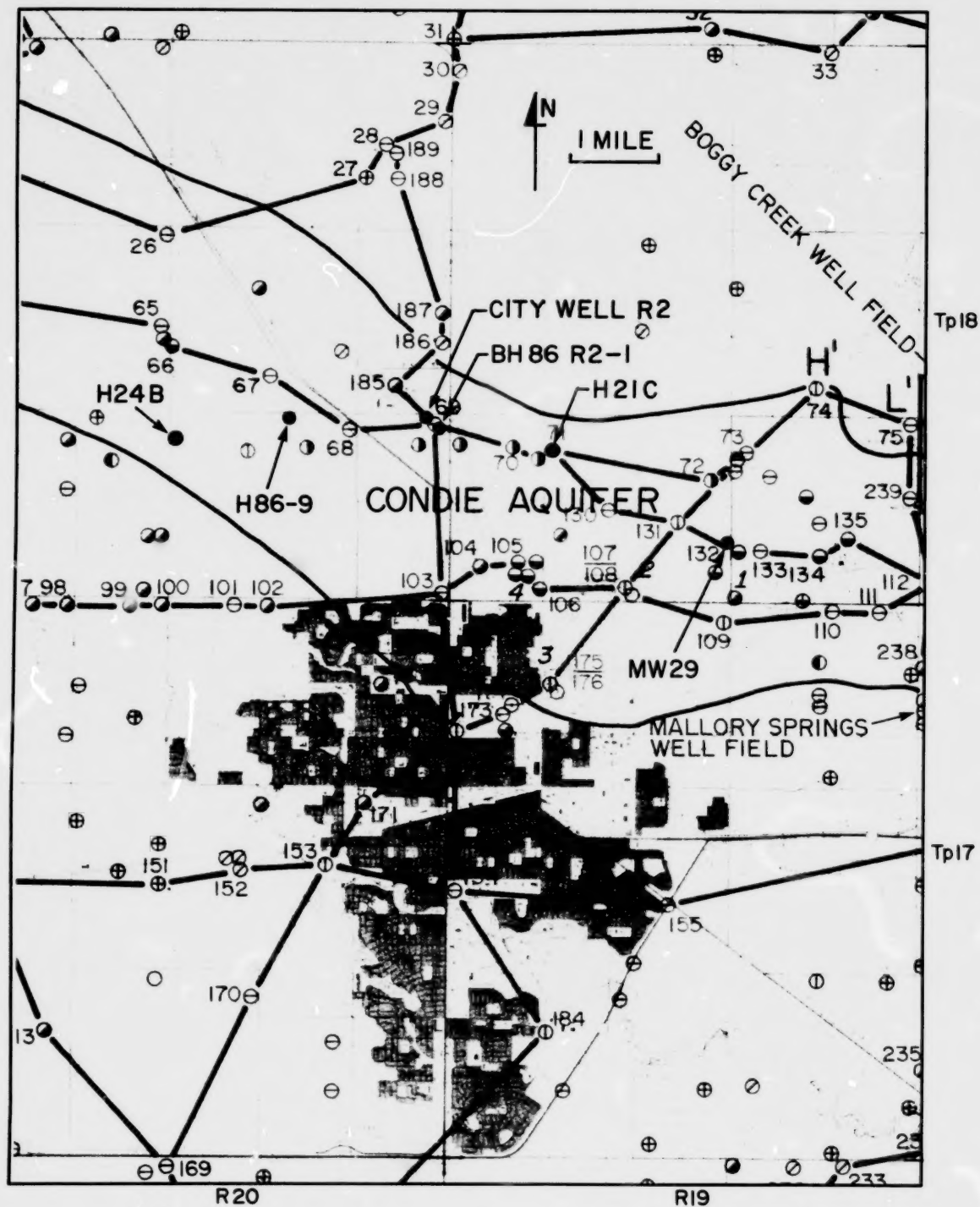


Figure 4.2-1 Locations of water level monitoring piezometers for the Condie Aquifer

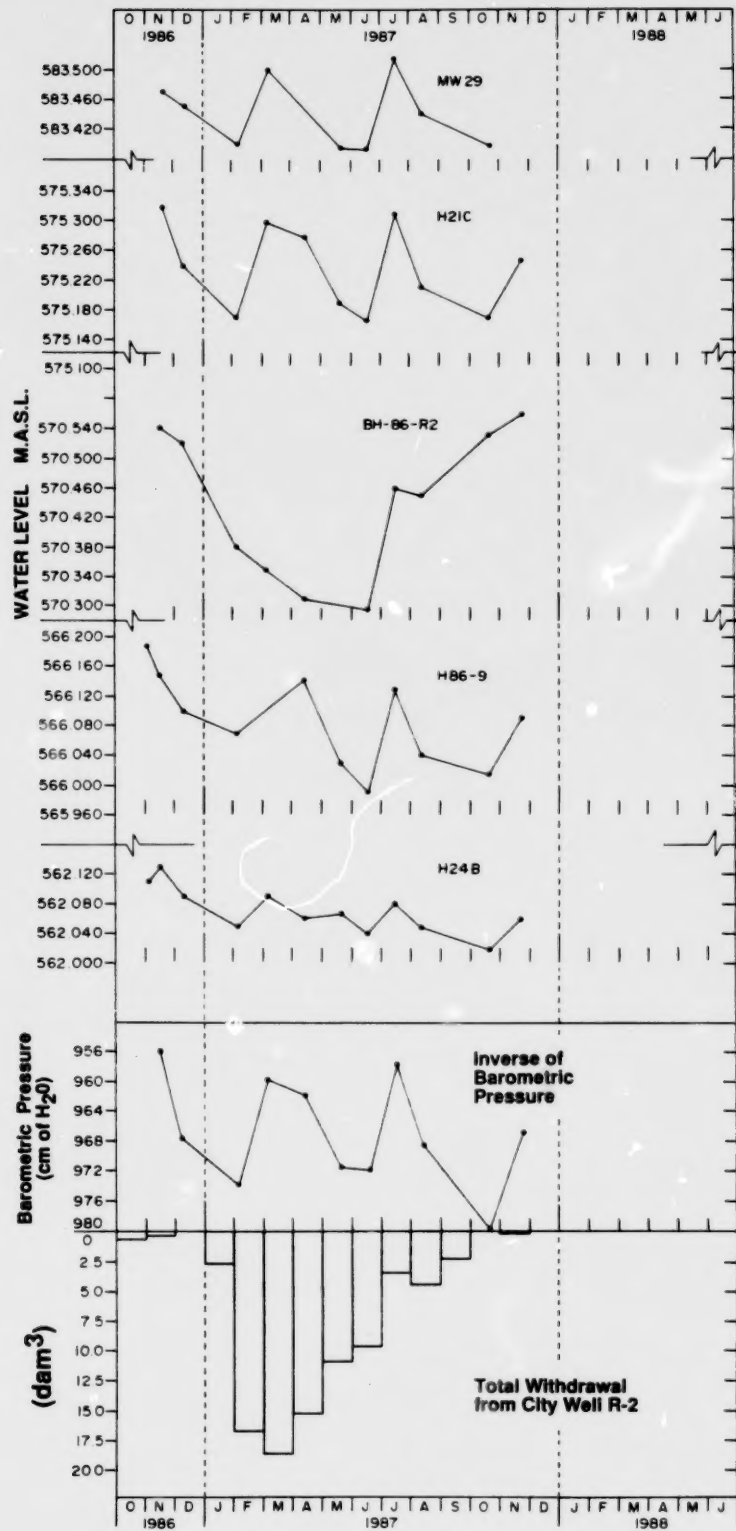


Figure 4.2-2 Monthly water level measurements and withdrawals for the Condie Aquifer, 1986-1987

Condie Aquifer (see Figure 4.2-3). In the eastern part of the Aquifer, the Pilot Butte-White City area, the data indicate that the piezometric surface slopes down to the south-west, corresponding to the general slope of the land. A detailed survey of water table elevations and contours in the Pilot Butte area on July 28, 1972 showed a similar gradient (D.H. Pollock, P.F.R.A., personal communication).

In the central portion of the Aquifer (Range 19 and east half of Range 20) there is a strong westerly gradient with hydraulic head highest at the central core of the Aquifer.

In the far western part of the Aquifer (west half of Range 20 and Range 21), there is an indication that there may be a localized mound in the piezometric surface, but accurate water-level data are not available. It should be noted that in much of this western section, the saturated portion of the Condie Moraine Sands and Gravels is only a few metres thick and in fact there may be no saturated sands at all in some locations.

Cross-section F-F', along the axis of the Aquifer, provides a detailed picture of the relative thickness of saturated and unsaturated sands within the Condie Moraine. The geophysical logs are a valuable aid in following the trend of the water table since the resistance log tends to "kick out" strongly above the water table.

Water-table conditions occur over virtually the entire area of the Condie Aquifer. Thus the hydraulic head contours also represent the water-table position and the top of the Aquifer (since the Aquifer comprises only the saturated portion of the Condie Moraine sands and gravels). The Aquifer may be in a semiconfined condition in the central

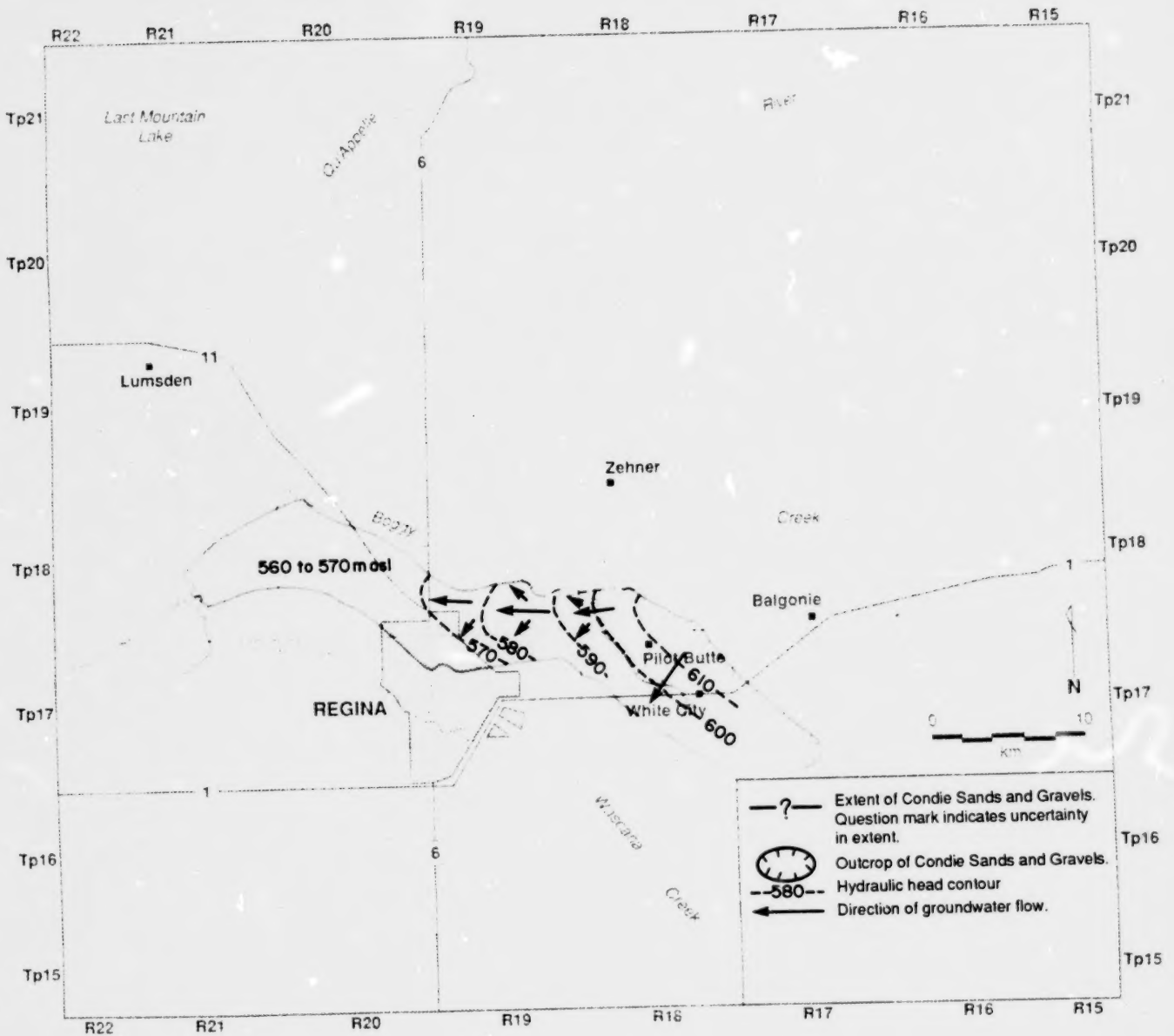


Figure 4.2-3 Hydraulic head and direction of groundwater flow in Condie Aquifer

area approximately southwest of the Boggy Creek well field, and also in places along its northern and southern edges.

When the first water line towards the Boggy Creek surface water reservoir was being dug in 1904 it encountered a large flow of groundwater when the trench cut through the surface clay in Sections 1 and 2, T18, R19, W2 (Hill et al, 1930). This flow presumably derived from the Condie Aquifer which in this area appears to be confined by the overlying clay and till.

4.3 Groundwater Quality in the Condie Aquifer

The natural groundwater quality in the Condie Aquifer is controlled by geochemical processes taking place between water infiltrating into the ground surface and surficial sediments, and perhaps to a minor extent by reactions between water in the aquifer and aquifer sediments. Introduction of contaminants due to industrial, agricultural and municipal activities may cause significant water quality changes. Chemical analyses, including repeat analyses, for the Condie Aquifer are listed in Appendix D, Table D-1. Map No. 8 (Maathuis and van der Kamp, 1988a) and Figure 4.3-1 shows the sample location, and total concentration of selected water quality data from the aquifer. It should be noted that if more than one analysis was available for the same sample location, data from the most recent analysis were used in preparing the map. Table 4.3-1 gives details of the water quality analyses indicated on Map No. 8 and Figure 4.3-1, including repeat analyses if available.

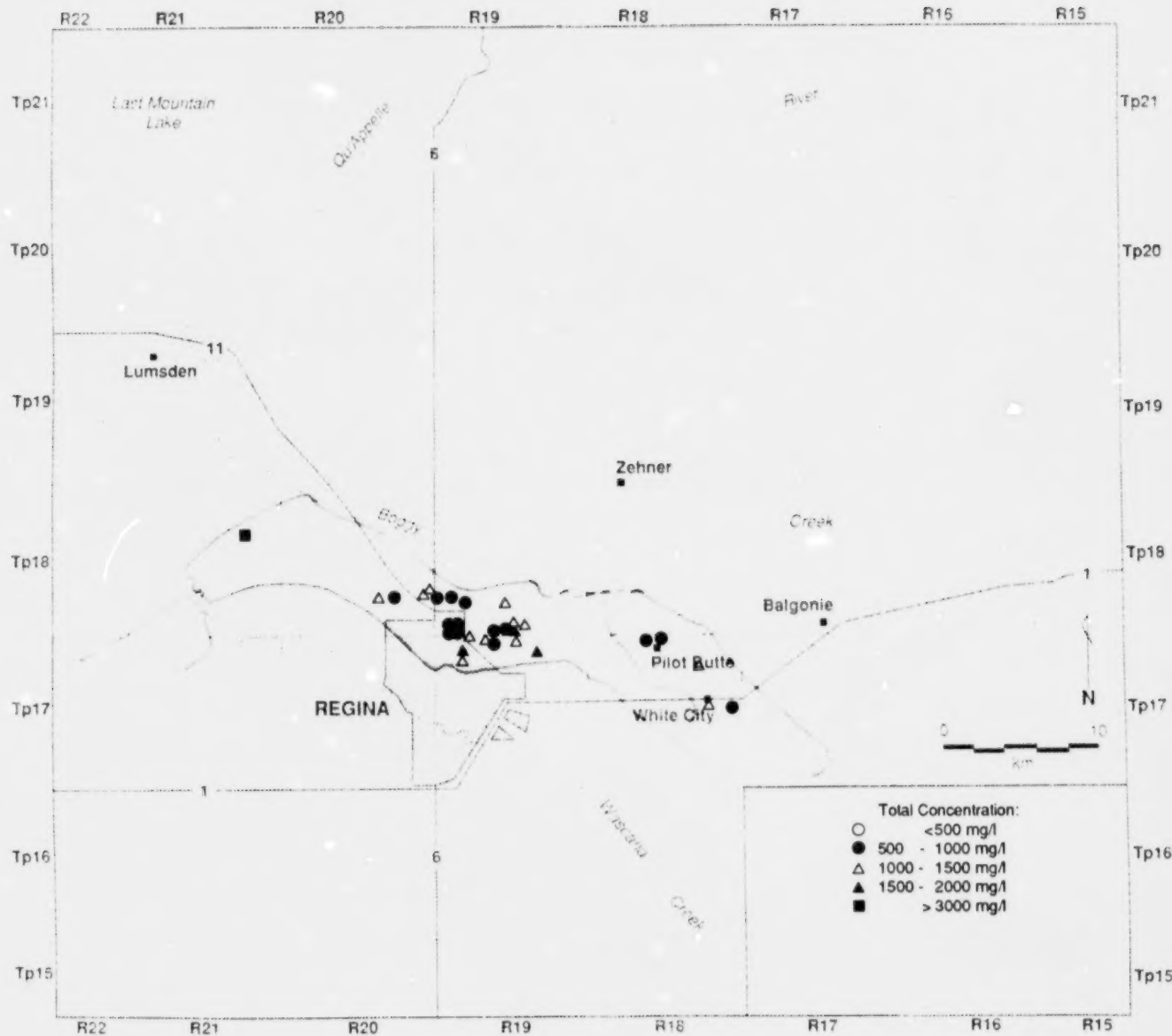


Figure 4.3-1 Distribution of total concentration in Condie Aquifer, based on selected groundwater quality data

It is evident from the map, and even more from Table D-1, Appendix D, that a large cluster of sample locations occurs in the central part of the Condie Aquifer (Range 19 and east half of Range 20). This cluster is the result of recent investigations pertaining to the impact or possible impact of industrial and municipal activities on the groundwater quality in the aquifer (Beckie Hydrogeologists, 1980; City of Regina, 1983; Clifton Associates, 1985). Water quality data in the central part of the Aquifer show a large variation in both total concentration and water type, without apparent patterns. The water quality data also show that there are not only significant lateral variations but also significant vertical changes. In addition to natural processes influencing water quality, infiltration of waste leachates and liquid wastes, at least locally, influence water quality (Beckie Hydrogeologists, 1980; Clifton Associates, 1985). It is significant that relatively good quality water, water with a total concentration of less than 1000 mg/l and of the calcium-bicarbonate type, has been encountered at scattered locations in this part of the aquifer. Water with such characteristics might be considered background and also is an indication of strong flow from the eastern part of the aquifer.

In the eastern part (Ranges 17 and 18) the Condie Aquifer forms a surficial aquifer. Consequently, in those areas remote from industrial or agricultural activities, it is expected the aquifer will yield water typical for surficial aquifers in Saskatchewan under similar conditions. Such surficial aquifers generally yield water of the calcium - bicarbonate type with a total concentration of less than 1000 mg/L (e.g. Meneley et al, 1979). Water with such characteristics is encountered in

the Pilot Butte area. However, since there are insufficient data points to establish background characteristics, it remains uncertain whether or not the water quality data in the Pilot Butte area truly represent background. The eastern part of the Condie Aquifer is highly susceptible to contamination from industrial, agricultural, municipal activities. In this regard the many gravel pits in this area should be mentioned a possible source from which contamination may spread. The high nitrate concentration of 418 mg/L for a sample taken at W2-18-17-23-SE (See Table 4.3-1) illustrates that, at least locally, contamination due to agricultural activity may occur.

In the western part of the Condie Aquifer (west half of Range 20 and Range 21) only one analysis is available (W2-21-18-26-02-SW). This analysis probably reflects a case of local contamination rather than being representative for the water quality in this part of the aquifer. This is in particular indicated by the high nitrate value of 159 mg/L.

To date, no data are available on the possible natural water quality changes in the Condie Aquifer. The changes in water quality since 1980 in water from the City of Regina's production well R2 (W2-20-18-12-NE see Table 4.3-1) are significant, in particular the increase in the chloride concentration probably is not natural.

During 1987 selected groundwater samples from the Condie Aquifer were analyzed for tritium content. The results of these analyses are given in Table 4.3-2. Tritium entered the atmosphere as a result of atmospheric nuclear tests between 1953 and 1969. Tritium concentrations of more than 5 to 10 tritium units (TU) imply that at least a significant fraction of the groundwater sample entered the groundwater zone

TABLE 4.3-2 TRITIUM CONCENTRATION IN WATER FROM CONDIE AQUIFER

SAMPLE WELL	LOCATION	SAMPLE DATE	TRITIUM (T.U.)	DESCRIPTION
MW 26	W2-19-18-03-05-NE	30/03/87	2.7 +- 0.7	NEAR LANDFILL WEST
MW 43	W2-19-18-04-08-SW	30/03/87	<0.8 +- 0.7	WEST OF ACTIVE LANDFILL
MW 52	W2-19-18-03-09-SE	30/03/87	16.4 +- 1.3	NORTH OF LANDFILL
MW 55	W2-19-18-03- -SW	30/03/87	<0.8 +- 0.7	UNDER LANDFILL
IO-8AL	W2-19-17-32-05-SW	30/03/87	<0.8 +- 0.7	FORMER IMPERIAL OIL SITE
IO-4AL	W2-19-17-32-04-NW	30/03/87	<0.8 +- 0.7	FORMER IMPERIAL OIL SITE
H86-1	W2-19-18-07-11-NE	01/05/87	<0.8 +- 0.7	RAIL RELOC. R.O.W. S.E. OF IPSCO
MP 2AL	W2-19-18-06-02-NE	04/05/87	2.3 +- 0.8	NEAR MT. PLEASANT LANDFILL
REG R2	W2-20-18-12-16-NW	04/05/87	7.6 +- 0.9	CITY WELL NEAR IPSCO

NOTE: DATA SUPPLIED BY CITY OF REGINA PUBLIC WORKS AND ENGINEERING
DEPARTMENT

after 1953 (Freeze and Cherry, 1979).

For the Condie Aquifer only 2 out of 9 samples had significant levels of tritium. The level of 16.4 TU for MW 52, east of the landfill is an indication of infiltration of surface water to the Condie Aquifer, east of the Landfill. The level of 7.6 TU for production well R2, beside the Albert Street Reservoir, indicates that some of the water withdrawn from Well R2 has originated from recent infiltration. The other seven out of nine samples from the Condie Aquifer contained little or no detectable tritium. This lack of tritium in the central portion of the aquifer implies that in this area there is little recharge through the overlying clay and till cover.

4.4 Groundwater Withdrawals and Water Level changes

The history of groundwater withdrawals from the Condie Aquifer is summarized in Table 4.4-1. The data as to rate and duration of withdrawals are approximate, but serve to indicate the overall pattern.

The principal user of groundwater from the Condie Aquifer in the period up to 1959 was the Canadian Pacific Railway which pumped water from its shallow well near Pilot Butte (W2-18-17-34) at rates of about 700 dam³/year (400,000 gallons per day, Hill et al, 1930, p. 82). Presumably withdrawals of groundwater by the Railway essentially ceased since the advent of diesel engines. The water withdrawn by the Railway was probably intercepted flow which would otherwise have discharged from nearby springs. No early water level data are available, but it is likely that the Railway's withdrawals had only a local effect on groundwater levels. The fact that this relatively high rate of withdrawals

TABLE 4.4-1 SUMMARY OF GROUNDWATER WITHDRAWALS FOR THE CONDIE AQUIFER

USER	LOCATION	AVERAGE WITHDRAWAL RATE (DAM3/YEAR)	FROM	TO	1987 RATE WITHDRAWAL RATE (DAM3/YEAR)
=====					
CANADIAN PACIFIC RAILWAY	W2-18-17-34	+700	+1900	+1955	0
10 INCH LINE FROM BOGGY CREEK WELL FIELD	W2-19-18-12	+660	1904	1959	0
REGINA PRODUCTION WELL R2	W2-20-18-16-NW	+222	1961?	PRESENT	88
GENSTAR CEMENT PLANT	W2-19-12-03-NW	+106	1958?	1980	0
TOWN OF PILOT BUTTE	W2-18-17-33	?	?	PRESENT	+200
TOWN OF WHITE CITY	W2-18-17-23	?	?	PRESENT	+110
RM OF EDENWOLD		?	?	PRESENT	+195
RM OF SHERWOOD		?	?	PRESENT	+107
=====					

appears to have been sustained for many years gives an indication of the potential yield of the eastern part of the Condie Aquifer.

From 1904 on the City of Regina obtained a steady flow of water by infiltration into a 15-inch tile conduit in Range 19, Tp 18, Sections 1 and 2. This conduit, left open at the tile joints, fed to a compensating basin and from thence to the City by a 10-inch steel line (Hill, 1930). The original hand-written records of the City's water supply, kept by the Saskatchewan Archives Board, show that the flow from the 10-inch line was used until at least 1959. It is not known when this line was actually abandoned. The yearly metered flow from the line as given in Appendix C, Table C-1 averaged about 660 dam³ per year. From time to time the seepage into the line was augmented by water pumped from nearby shallow wells, such as BC 178 (Lissey, 1962, Plate 3). The water is assumed to have come from the Condie Aquifer which is confined by clay and till in Sections 1 and 2 of Range 19, Township 18.

City well R2 was completed in the Condie Aquifer in 1960 near the Albert Street Reservoir (W2-20-18-12-16-NW). Early production data are not available, but for the period 1969 to 1987 the average withdrawal rate was 222 dam³/year (see Appendix C, Table C-1). Several accurate static water level measurements have been recorded for well R2 and for observation wells drilled nearby (Appendix B). They are as follows:

November 12, 1959	571.4 m (?)	TH3-IWS59
July 12, 1960	570.77 m	R2
March, 1963	570.74 m	R2
---, 1980	570.56 m	R2
November 5, 1986	570.91 m	R2

November 23, 1987

570.56 m

BH 86-R2-1

These data show remarkably little change of the water level despite a total withdrawal by well R2 from 1961 to 1987 of about 6000 cubic decameters. This finding is consistent with the monthly water-level measurements since November 1986 (see Section 5.2, Figure 4.2-1). These show at most about 30 cm of drawdown in BH 86-R2-1 (about 20 m from R2) in response to withdrawal of about 88 dam³ from R2 during the summer of 1987.

The Inland Cement Company (Genstar since 1982) pumped water from a well completed in the Condie Aquifer (W2-19-18-03-NW), from 1958 or 1959 until 1980. The average withdrawal rate for the period 1968 to 1980 (Appendix C, Table C-2) was 106 dam³/year. Water level data are not available. The company is now pumping from a well completed in a lower aquifer.

Stanley Associates (1988) made an estimate of the water being withdrawn at present from the Condie Aquifer by wells in the town of Pilot Butte and White City. They arrived at rates of about 200 and 110 cubic decameters respectively for 1987. Stanley Associates (1988) also estimated the withdrawals from the Condie Aquifer within the Rural Municipalities of Edenwold and Sherwood. These withdrawals, reflecting scattered domestic industrial and agricultural use, amount to about 195 and 107 cubic decameter per year at present, for the RM's of Edenwold and Sherwood respectively.

Some early data on water levels in the Condie Aquifer have been identified (see Appendix B) in the reports by Wynne-Roberts (1912) and Mackay, Beach and Scott (1936). They are as follows (the data in

brackets are the present water levels, estimated from the data shown on Map No. 7 (Maathuis and van der Kamp, 1988a):

W2-19-18-02-NE	1935	588 m	(589 m)
W2-19-18-02-SW	1935	589 m	(585 m)
W2-19-18-03	1912	583 m	(582-585 m)
W2-19-18-04	1912	584 m	(578-583 m)
W2-19-18-04-SE	1935	581 m	(582 m)
W2-20-18-09-NW	1935	567 m	(562 m)
W2-10-18-13-SW	1935	565 m	(569 m)

The 1912 and 1935 water levels are about the same as recent levels in the same area. These data and the water level data for well R2 suggest that the water levels in the Condie Aquifer have probably been relatively steady in this century. However, the early water-level data are unreliable and water-level changes of up to several metres cannot be excluded for the years prior to 1960.

4.5 Hydraulic Properties of the Condie Aquifer

Lissey (1962, p. 76-79) reports detailed data for a pumping test conducted on well R2 (W2-20-18-12-NE) in 1961, with three observations wells. The saturated thickness of the Condie Aquifer at well R2 was 10.7 m. The test yielded a transmissivity of $2.5 \times 10^{-2} \text{ m}^2/\text{sec}$, and a specific yield of 0.24. The hydraulic conductivity is $2.3 \times 10^{-3} \text{ m/sec}$. These values of specific yield and hydraulic conductivity are characteristic for a coarse sand.

A pumping test carried out in 1959 on the cement plant well (W2-19-18-03-NW) indicated a similar high transmissivity for the Condie Aquifer

(approximately 0.6 m drawdown in the pumping well after 48 hours of pumping at 11.3 L/sec, letter from McPherson and Thorn Limited to Saskatchewan Cement Company, June 17, 1959).

Clifton Associates (1985) report hydraulic conductivities for the sands of the Condie Aquifer, in the area of the Co-op Refinery, ranging from 1.4×10^{-6} m/sec to 8×10^{-5} m/sec, based on piezometer slug tests.

Clearly the transmissivity of the Condie Aquifer can vary widely depending on the saturated thickness and effective grain-size of the sands. The value obtained from the pumping test on well R2 is very high and is probably a near-maximum value for the Condie Aquifer. In general it appears that the more permeable sands and gravels occur at the bottom of the Aquifer along its central axis. Finer sands are encountered along the flanks of the Aquifer.

4.6 Groundwater Regime of Condie Aquifer.

The data discussed in the previous sections indicate that the Condie Aquifer forms a continuous highly permeable hydrogeological unit with an active groundwater circulation. Hydraulic head contours (See Figure 4.2-3) show that the overall gradient has strong east to west component along the axis of the aquifer from about the Pilot Butte area (middle of Range 18). The average value of the east-west gradient is about 2.1×10^{-3} . This gradient, combined with a hydraulic conductivity of the most permeable zone of up to 2×10^{-3} m/sec, implies that groundwater may move by up to 400 metres per year in the aquifer. The total east to west flow in the eastern half of Range 19 is probably in the range of 600 to 1200 dam^3/year , assuming a 500 to 1000 m width of the

aquifer with a high transmissivity of $0.02 \text{ m}^2/\text{sec}$). This amount of groundwater movement constitutes an important component of the general groundwater balance in the Regina area.

In the Pilot Butte area there is also a marked transverse component of the gradient indicating a flow component from northeast to southwest across the aquifer (See Figure 4.2-3).

In the western part of the aquifer, south of the Condie Reservoir, there appears to be a separate groundwater "high", which is probably separated from the flow in the rest of the Aquifer by "dry" zones of the Condie Sands and Gravels.

The groundwater circulation pattern in the Condie Aquifer can be outlined as follows. In the Pilot Butte area there is strong recharge to the aquifer by infiltration at the ground surface, and also from gravel pits and streams. Much of this water probably discharges again relatively nearby to springs and seeps. The hydraulic gradient in this area largely reflects the surface topography since the aquifer is essentially a thin cover of sand and gravel draped over a regional slope. As will be discussed in a following chapter, in this area the hydraulic heads in the underlying aquifer zones appear to be slightly higher than in the Condie Aquifer but the degree of interaction between the aquifers is not known.

Further to the west, approximately in Ranges 19, 20 and 21 the character of the flow regime changes. Recharge is largely by east-to-west flow originating in the Pilot Butte - Boggy Creek Reservoir area. There is also recharge by infiltration from the ground surface, but this component is probably relatively small due to the presence of a surface

cover of Regina Lake clay and Battleford till. Surface infiltration may be relatively strong in two smaller areas; the slough (W2-19-18-2) just north of the Correctional Institute and the gravel pits at the topographic high south and west of the Town of Condie. There may be a recharge or discharge component from Boggy Creek at Boggy Creek Reservoir. The degree of hydraulic connection between the Condie Aquifer and Boggy Creek in the area is not known at present.

Discharge from the western part of the aquifer is almost entirely by downward flow through the underlying glacial till to the aquifer below. This flow will be further discussed in a following chapter. There is probably a minor discharge component to Wascana Creek in Range 21, Township 18 where the creek valley cuts through the aquifer. There also appears to be a minor discharge component (less than 1 L/sec) to the Boggy Creek Valley in Range 20, Township 18, particularly to the diversion ditch south of the Condie Reservoir.

The limited data on withdrawals and change of water levels suggest that withdrawals have had little effect on water levels. This result is consistent with the picture of the Condie Aquifer as a highly permeable aquifer with strong through-flow. The withdrawals from the central part of the aquifer, averaging about 350 dam³/year since 1959, constitute only a part of the total through-flow, estimated at 600 to 1200 dam³/year.

As will be discussed in a following chapter, the hydraulic head in the underlying Regina Aquifer appears to have decreased by about 5 metres since the start of groundwater withdrawals. Most of the discharge from the western part of the Condie Aquifer is now downward to

the underlying aquifer, but it would appear that before groundwater withdrawals started, the downward flow to the underlying aquifer would have been less, and more of the discharge may have gone directly to Boggy Creek and Wascana Creek. It follows that water levels in the western part of the Condie Aquifer may have been slightly higher in the first decades of this century than at present. However, the limited early water-level data that have been identified are not reliable enough to indicate whether or not the water levels were higher.

At present there are no continuous water-level records available for the Condie Aquifer. Monthly water level measurements show that seasonal fluctuations are less than 0.20 metres in the central part of the Aquifer. Larger fluctuations may occur in the eastern part of the aquifer, particularly at points where the groundwater interacts with surface water.

The water quality data (See Figure 4.3-1) are roughly consistent with the foregoing interpretation of the groundwater regime. Total concentration values are generally low in the Pilot Butte area, where most of the recharge occurs. Further west the values are higher and more erratic as are water types. These water quality data presumably reflect water of mixed origin. Infiltration of waste leachates and liquid wastes has influenced the water quality. The occurrence of calcium-bicarbonate water with low total dissolved ion content at some locations is consistent with the hypothesis that there is strong lateral recharge of good quality water from the east through the narrow but highly permeable core of the aquifer. If such flow, at velocities of up to 400 metres per year, does occur it would have important implications

for potential contaminant transport.

4.7 Water Balance

The lack of long-term accurate water-level records and pumping records precludes an accurate assessment of the water balance of the Condie Aquifer. The overall balance is dominated by strong recharge in the eastern surficial part of the aquifer, lateral flow into the central part, and downward flow from the central part of the aquifer into the underlying Regina Aquifer. In the Boggy Creek well field area the geological setting is complex. The continuity of the Condie Aquifer in this area and its interaction with underlying aquifer zones and with surface water are not known. The data suggest that there is a strong westward flow from the Boggy Creek well field area through the Condie Aquifer.

The eastern exposed part of the aquifer covers an area of about 65 km² (see Maathuis and van der Kamp, 1988a: Map No. 2). Assuming an average recharge rate to these surficial sands of 5 cm/year, the total recharge to the aquifer in this area is about 3000 dam³/year. In addition there may be some upward flow from underlying aquifer zones, particularly in the area around Pilot Butte. The recharge can easily sustain the present withdrawals in this area which amount to about 400 or 500 dam³/year, not all consumptive. (Historically the aquifer sustained long-term withdrawals by means of the 10-inch line, amounting to about 660 dam³ per year, plus the Canadian Pacific Railway withdrawals of about 700 dam³/year, without deleterious effects being reported). The remaining recharge discharges to local springs and seeps and about

600 to 1200 dam^3/year flows into the central part of the aquifer.

It must be kept in mind that there may be considerable flow into and out of the aquifer in the area of the Boggy Creek well field.

With a 65 km^2 area of the exposed part of the aquifer, and assuming a specific yield of 0.2 and 1 metre of available drawdown, the total water in active storage at the water table amounts to about 13,000 dam^3 . This large stored volume could sustain the outflow and pumping withdrawals for several dry years, even in the total absence of recharge.

In the central part of the aquifer practically all the recharge is by lateral flow from the east, estimated at 600 to 1200 dam^3/year . Local recharge via sloughs and the western gravel pits probably amounts to no more than 100 or 200 dam^3/year . Virtually all this total recharge is subsequently lost from the aquifer by vertical downward flow to the Regina Aquifer. A small component is withdrawn via City well R-2 which has averaged 222 dam^3/year since 1968.

The central part of the aquifer has about 45 km^2 with water table conditions. Assuming a specific yield of 0.20, the active storage per meter drawdown of the water table is therefore about 9000 dam^3 . The total volume of water stored in this part of the aquifer is about 50,000 to 100,000 dam^3 , most of which is available for recharge to the underlying Regina Aquifer.

Between 1959 and 1987 total of about 9000 dam^3 have been withdrawn from the central part of the Condie Aquifer by means of the Cement Plant well (W2-19-18-03-NW) and City Well R2 (W2-20-18-12-NE). The intriguing fact is that there has been no identifiable drawdown of the water level

near well R2 between 1961 and 1987. Certainly the drawdown is much less than the one metre or more that would be expected if all the water had come from storage. This finding confirms extensive lateral continuity of the highly permeable central core of the aquifer and strong lateral recharge. By way of comparison, the lateral inflow from the east (see Section 4.5) has been calculated to be about 600 to 1200 dam³ per year or 22,000 to 44,000 dam³ over the period 1959 to 1987.

Judging by the piezometric surface and the saturated thickness of the Condie Aquifer, it seems likely that most of the lateral flow from the east flows down into the Regina Aquifer in the west half of Range 19 and the east half of Range 20. This deduction is strengthened by the fact that the till between the Condie and Regina Aquifer is thinnest in this area (see Maathuis and van der Kamp, 1988a: Map No. 4). The interaction between these two aquifers will be further discussed in Chapter 5.

In the western part of the Condie Aquifer the saturated thickness is generally less than 3 m, and in fact over part of this area the Condie Moraine is dry. Groundwater storage is at present relatively small, but the potential storage capacity is very large.

4.8 Susceptibility to Contamination

Due to its near-surface position and high permeability the Condie Aquifer is highly susceptible to contamination by surface pollutants. It is likely that the water quality in much of the aquifer is already affected by man's activities. In some places the water quality is unacceptable for drinking purposes due to contamination by nitrates,

salts, landfill leachates and seepage from disposal lagoons.

In the eastern part of the aquifer the sands occur at ground surface and the groundwater can therefore be easily contaminated. The main concern here is the water supply for the towns of Pilot Butte and White City. In the vicinity of these towns the groundwater quality will need to be monitored and protected if possible.

The central part of the Condie Aquifer is overlain by a zone of unsaturated sand and silt and by a cover of till and clay. This cover protects the aquifer from minor spills. However, a considerable amount of contamination has occurred, principally via sloughs or holding ponds which penetrate through much or all of the clay and till cover, and which enhance infiltration by the constant availability of surface water.

The high permeability of the aquifer, particularly in its central core is important with regard to the movement of contaminants. A flow velocity of as much as 400 metres per year has been calculated for the central core. This high velocity implies that once contaminants enter the more permeable zone they may move a distance of kilometres in a few years. For example, it is distinctly possible that the increasing chloride levels in City Well R2 may be related to the high chloride concentrations encountered in W3-19-18-3 (see Appendix D, Table D-1), about 6 kilometres east of the well site. This possibility is of course by no means proven, but gives an indication of the distance and time scales that must be considered when dealing with contaminant transport in the Condie Aquifer.

In the far western portion of the aquifer the gravel pits on the

ridge south of Condie present an obvious potential entry point for contaminants. Since this part of the aquifer may well be used in the future for water storage, protection of the aquifer may be necessary.

5. GROUNDWATER RESOURCES OF THE REGINA AQUIFER

5.1 Definition and Extent of the Regina Aquifer

5.1.1 Hydraulic Discontinuity Range 19, Township 18

Van der Kamp and Maathuis (1985) identified, based on water level data, a major hydraulic discontinuity in the Upper Floral Sand and Gravel area in the southeastern part of Range 19, Township 18. The testhole drilling carried out in 1986 allows a further interpretation of the location and nature of this discontinuity (Maathuis and van der Kamp, 1988a: Map No. 3). Cross sections E - E' (logs 110 to 112), F - F' (logs 134 to 112) and logs 112 to 75 on cross section L - L' (see Maathuis and van der Kamp, 1988a) indicate the following:

- significant changes in the elevation of the top and bottom of the Upper Floral Sand and Gravel aquifer are encountered in the area of the discontinuity. These changes are the probable result of collapse.
- testhole logs 75, 135 and 239 also indicate that the Upper Floral Sand and Gravel aquifer at these locations is composed of sand with numerous silt interbeds (log 75), and sand and significant silt layers (e.g. log 239). In other words, in the area of the discontinuity, there is a great reduction in the transmissivity of the Upper Floral Sand and Gravel aquifer.

The hydraulic head data for the Upper Floral Sands and Gravels (see Maathuis and van der Kamp, 1988a: Map No. 9) are the clearest evidence of a hydraulic discontinuity. There is a 20 to 30 metre difference in hydraulic head over a distance of 3 to 4 km in the eastern half of Range 19, Township 18. West of this area the piezometric surface is

practically flat.

Taken together, the water-level data and the geological data clearly show the presence of a barrier to groundwater flow, as indicated on Map No. 3 and No. 9 (Maathuis and van der Kamp, 1988a). This barrier therefore is taken as constituting a more or less impervious boundary between two different aquifers. In the context of the regional groundwater regime this barrier plays a pivotal role. Without this barrier the flowing springs around which the Boggy Creek and Mallory Springs well fields were located would not have existed. Water would flow from further northeast without interruption through the Upper Floral sands and gravels directly north and west of the city to discharge into Wascana Creek and Boggy Creek in Ranges 20 and 21.

5.1.2 Definition of the Regina Aquifer

The Regina Aquifer is hereby defined as all the sand and gravels of the Upper Floral Formation shown as continuous on Map No. 3 (Maathuis and van der Kamp, 1988a) and west of the hydraulic barrier in Range 19, Township 18. The outline of the Regina Aquifer is shown in Figure 5.1-1. This definition is based on the geological evidence for continuity plus the hydraulic head data, which show a remarkably "flat" piezometric surface throughout the area defined as the Regina Aquifer (see Maathuis and van der Kamp, 1988a: Map No. 9).

Cross sections J - J' (logs 149 to 95) and logs 150 to 96 on cross section K - K' (Maathuis and van der Kamp, 1988a) suggest the existence of a discontinuity in the Upper Floral Sands and Gravels in the north part of Ranges 20 and 21, Township 17 (see Figure 5.1-1). However,

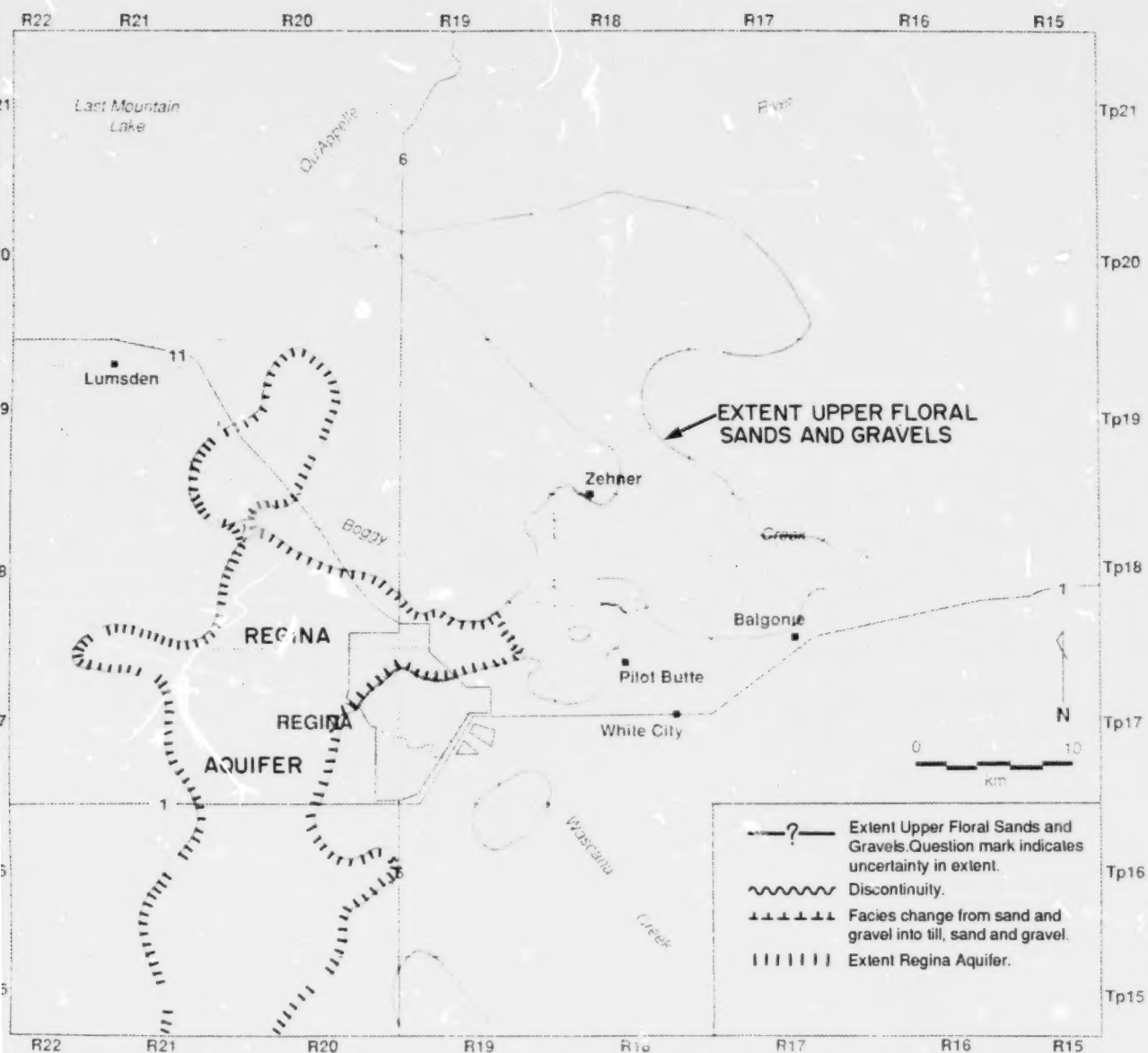


Figure 5.1-1 Extent of the Regina Aquifer

since there are no testholes penetrating bedrock in the area of the inferred discontinuity, the nature and degree of discontinuity remains unestablished. Water level data in the aquifer south of the discontinuity, although scarce, do not support the existence of a hydraulic discontinuity.

Cross sections B - B' (logs 24 to 26) and logs 63 to 218 on cross section K -K' (Maathuis and van der Kamp, 1988a) suggest a discontinuity of the Upper Floral Sands and Gravels in the north part of Ranges 20 and 21, Township 18. However, the existence of strong flowing springs along the south side of the Boggy Creek valley in W2-20-19-6, provide strong evidence of hydraulic continuity with the main portion of the Regina Aquifer to the south. The Upper Floral aquifer zone in the Tregarva area north of this apparent geological discontinuity is therefore taken to be part of the Regina Aquifer. Further test drilling in the northwest of Township 18, Range 20 will be needed to confirm the continuity of the Regina Aquifer.

In the southwest (Ranges 20 and 21, Township 15), the Upper Floral Sands and Gravels may continue southward beyond the study area. Although the data are scarce in this area, Hardy Assoc. (1985) suggest that these sands may be continuous with the Weyburn Valley Aquifer which extends far to the south-east. For the present purpose the south boundary of the Regina Aquifer is arbitrarily taken at the south side of Township 16, Ranges 20 and 21. There is no major pumping anywhere near this boundary. The water-level data indicate a very low hydraulic gradient and hence little or no flow across this boundary.

The extent and thickness of the Interglacial Sediments are shown on

Map No. 5 (Maathuis and van der Kamp, 1988a). The extent is also shown in Figure 2.9-1. These sediments include aquifer zones lying beneath the Upper Floral Sands and Gravels of the Regina Aquifer. The geological data do not show direct hydraulic connection between the two. The water level data (Maathuis and van der Kamp, 1988a: Map No. 9) indicate a partial connection only. In particular the hydraulic head for R8-OBS, near City Well R8, (W2-19-17-30-12-SW) rises at times to 3 or 4 metres higher than the head in the Regina Aquifer nearby, suggesting that R8 is completed in a relatively independent aquifer zone. However, little or no recharge can enter these aquifer zones except via the overlying or adjacent sands of the Upper Floral Formation. For water balance purposes it is therefore reasonable to include them with the Regina Aquifer, though constituting only a small and perhaps poorly connected part.

5.2 Piezometric Surface

Detailed piezometric data for the Regina Aquifer are shown on Map No. 9 (Maathuis and van der Kamp, 1988a) and are summarized in Figure 5.2-1. The accurate data from the instantaneous piezometric surface (IPS) measurements are of particular value for indicating gradients on an otherwise remarkably "flat" piezometric surface.

The IPS data for November 23, 1987 shown on Map No. 9 indicate a drawdown cone around the Co-op Refinery wells (W2-19-18-5) and nearby city wells (R5, R6, R7, R8). The IPS data for April 14 and Aug 12 show a similar drawdown cone. Total withdrawals from these wells amounted to 1651 dam³ in 1987, or 58 per cent of the total withdrawals from the

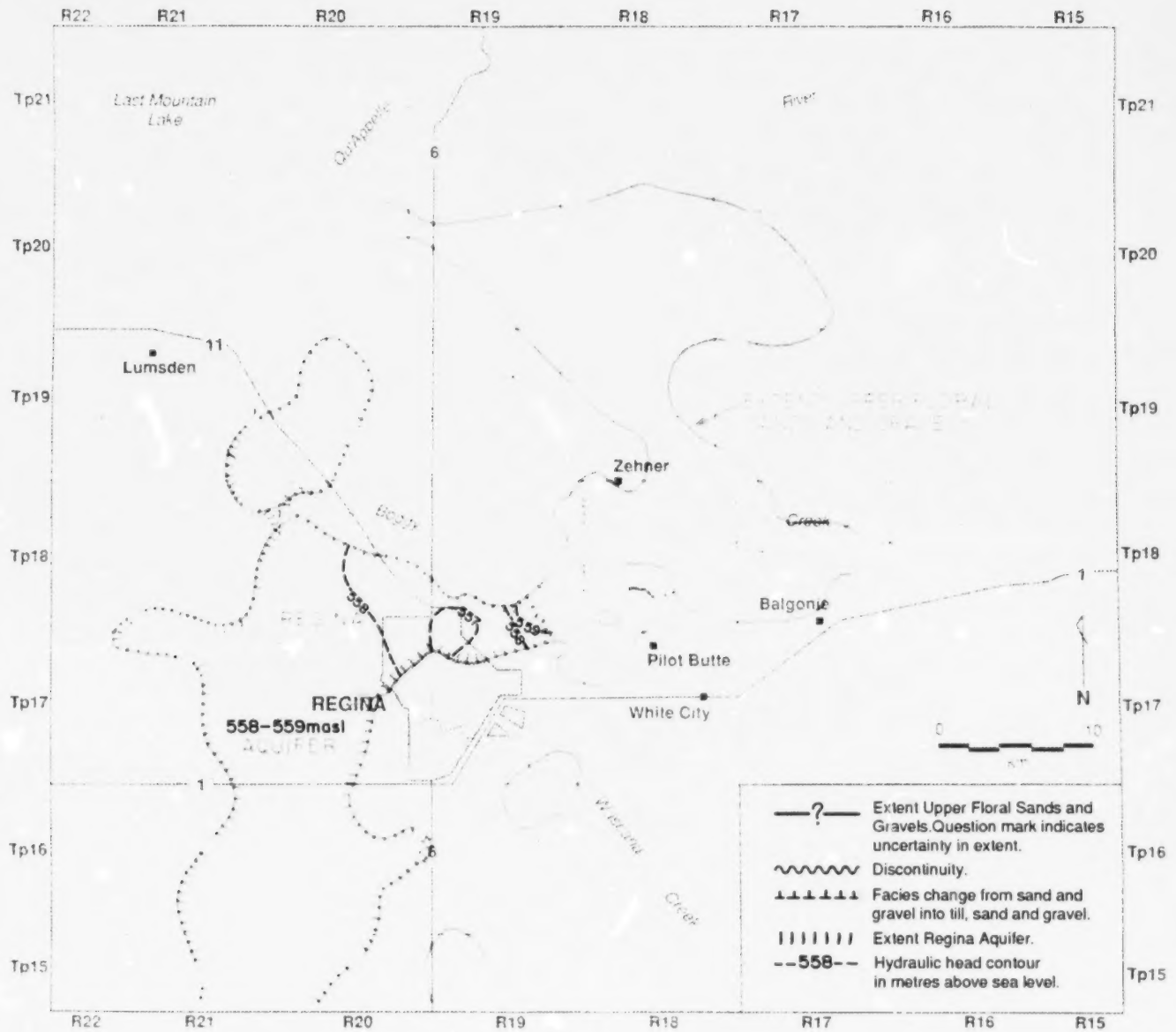


Figure 5.2-1 Piezometric surface for the Regina Aquifer

Regina Aquifer (data from Appendix C and City of Regina detailed production data).

In the area of the landfill (W2-19-18-3) there is locally a strong gradient from the north-east. This gradient indicates relatively strong lateral inflow into the Regina Aquifer through a as yet unidentified "opening" in the hydraulic barrier separating it from the aquifers to the east.

An important feature of the piezometric surface is the lack of a permanent drawdown cone around the western wells W1 to W5. These wells produced 908 dam³ in 1987, or 32 per cent of the total. Pumping from these wells had ceased by November. The IPS data for August 12 indicate a drawdown cone around the wells, but it appears to be gone by November 23, indicating very high transmissivity and/or strong recharge.

5.3 Groundwater Withdrawals and Water-Level Changes

Groundwater has been withdrawn from the "Regina Aquifer" at steadily increasing rates since the year 1883. Estimated withdrawals, based on the data presented in Appendix C are shown in Figure 5.3-1, averaged over 10-year intervals. Prior to 1969 only a few rough estimates of withdrawals are available and hence there is considerable uncertainty as to the actual withdrawals. There is little doubt however that the overall increase of withdrawals as shown in Figure 5.3-1 is roughly correct.

Also shown in Figure 5.3-1 are the averages of all static water levels recorded for the Regina Aquifer, as listed in Appendix B, also averaged over 10-year intervals. Together with these averaged data,

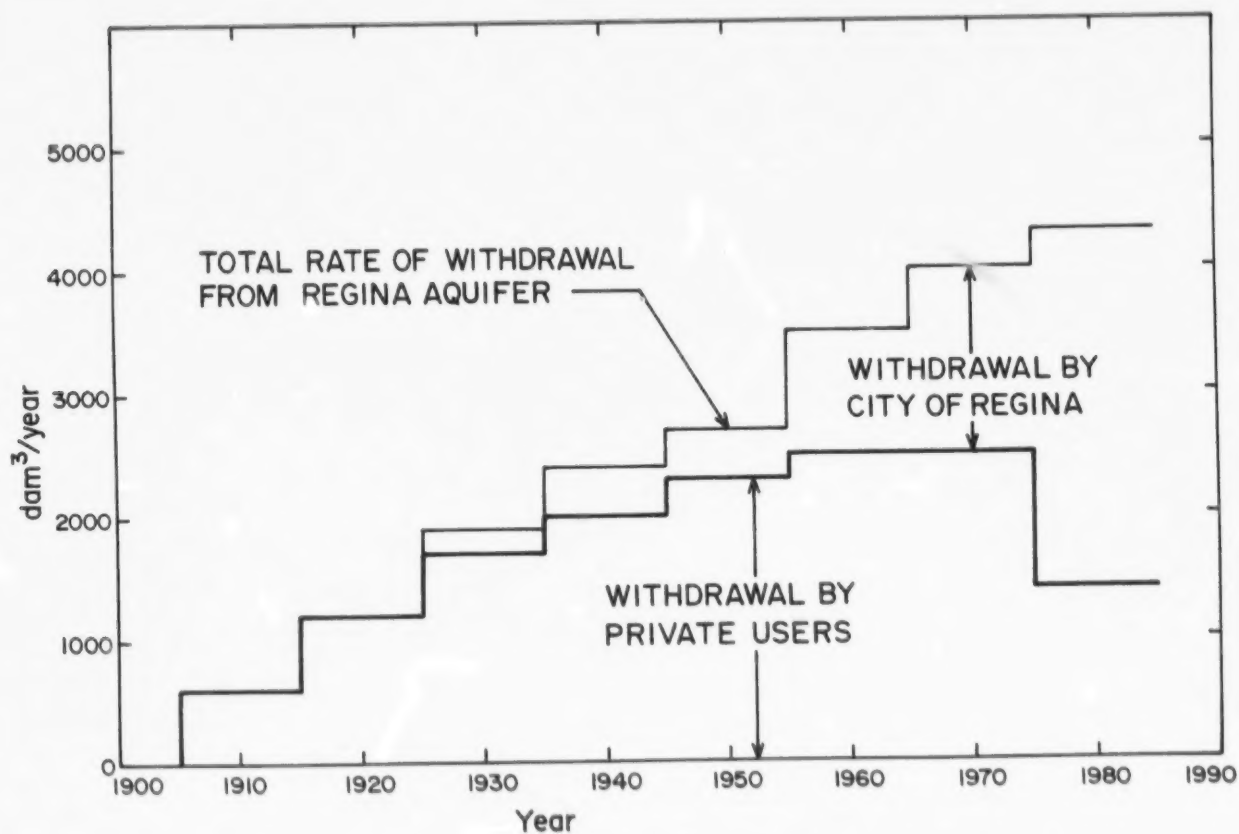
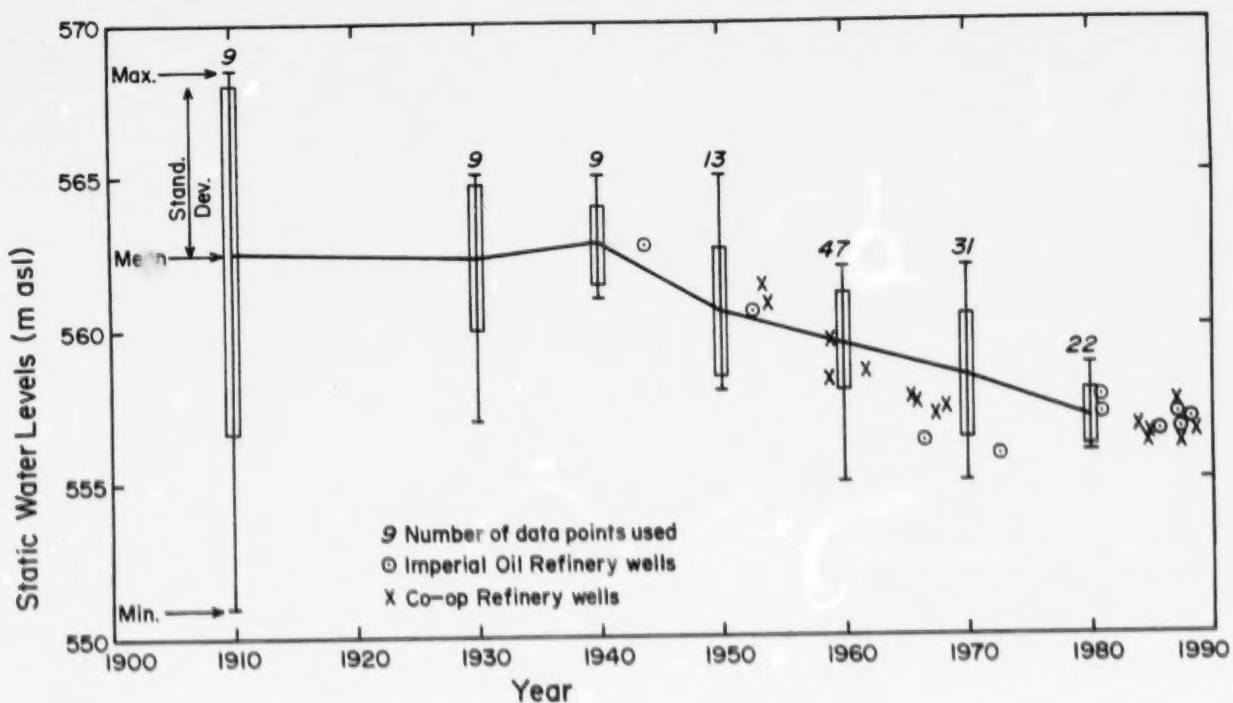


Figure 5.3-1 Averaged water levels and estimated average withdrawals for the Regina Aquifer, 1905-1987

individual reliable (surveyed) data for the Imperial Oil Refinery wells and the Co-op Refinery are also plotted. The standard deviations and the maximum and minimum levels are also shown. The very early data, for 1910, are taken from the report by Wynne-Roberts (1912). The large spread in these data are a reflection of the inaccuracies inherent in these early data, which are reported as the height to which water rose above the bottom of the well.

The water-level data clearly show a drop in static water-levels of about 5 to 6 metres between 1940 and 1980. The accurate data from the oil refinery sites follow the general trend, with small deviations due to localized drawdowns around the refinery pumping wells. It is likely that some water-level decline occurred prior to the 1945-1955 decade since there were significant withdrawals prior to 1945. The early water-level data are unreliable and do not exclude this possibility. In fact Hill et al (1930) report that static water levels at the Imperial Refinery site had dropped by 0.6 to 0.9 m since the start of pumping in about 1915.

The first well in the City area was drilled to 29.6 m (97 feet) on the 24th of April, 1883, at the intersection of Broad St. and South Railway St. A static water level of 9.1 m (30 feet) below ground was reported, or about 568 m asl. (See Appendix B, W2-19-17-14-SE). This well probably drew water from the Interglacial Sediments and the static level gives a rough indication of the undisturbed piezometric level in the Regina Aquifer.

The relatively small spread of the data points for each 10-year interval from 1930 onward show that the "flatness" of the piezometric

surface has been maintained through the years. In other words, the static water levels have declined at a roughly equal rate throughout the aquifer. This general pattern confirms that the Regina Aquifer, as defined in this report, is indeed hydraulically continuous throughout.

The accurate water-level data obtained from the Refinery sites suggest that since the mid-sixties the water-levels may have levelled out at least in the area of the refineries. This effect may be in part due to the cessation of pumping at the Imperial Oil refinery since 1975, but if the decline is still continuing it certainly is not as rapid as during the period from about 1945 to 1965.

Continuous water level records are available for the period 1978 to 1987 from the Saskatchewan Research Council's observation well (W2-20-18-15-12-NW) completed in the Regina Aquifer to the northwest of the City. These records show irregular variations of the water level of up to 1 metre (see Figure 5.3-2). The water level appears to be influenced by pumping from City of Regina wells W1, W2, W3, W4 and W5, south of the observation well. Also shown in Figure 5.3-2 are the total yearly withdrawals from the Regina Aquifer since 1969, as listed in Appendix C. The water level in the observation well appears to have declined by about one metre in response to the high withdrawals in 1979 and 1980, but since then the level has been more or less stable, averaging about 558 metres. These continuous data are consistent with the longer-term trend shown in Figure 5.3-1.

Since November 1986 monthly water-level measurements have been obtained from piezometers H24A, H21B, and MW44. These water-level data are plotted in Figure 5.3-3 together with water-level elevations taken

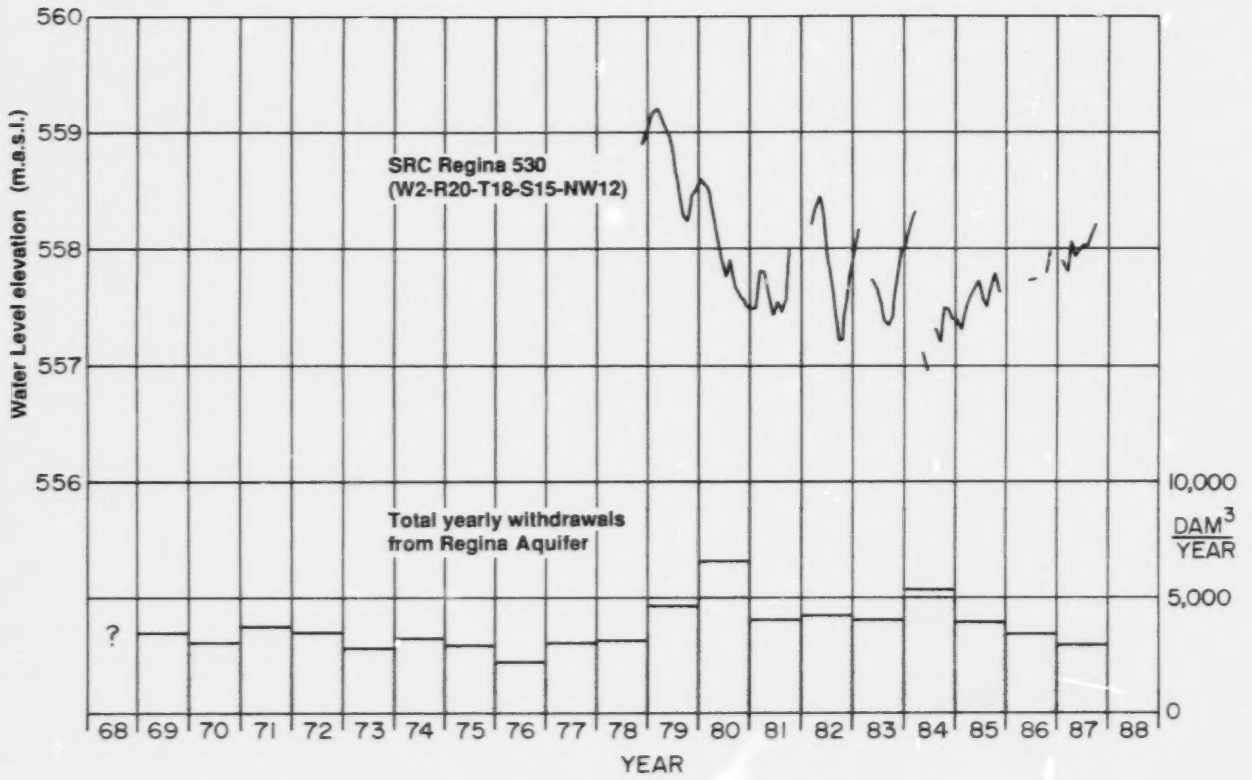


Figure 5.3-2 Water level records for SRC Regina 530 and total withdrawals for Regina Aquifer, 1968-1987

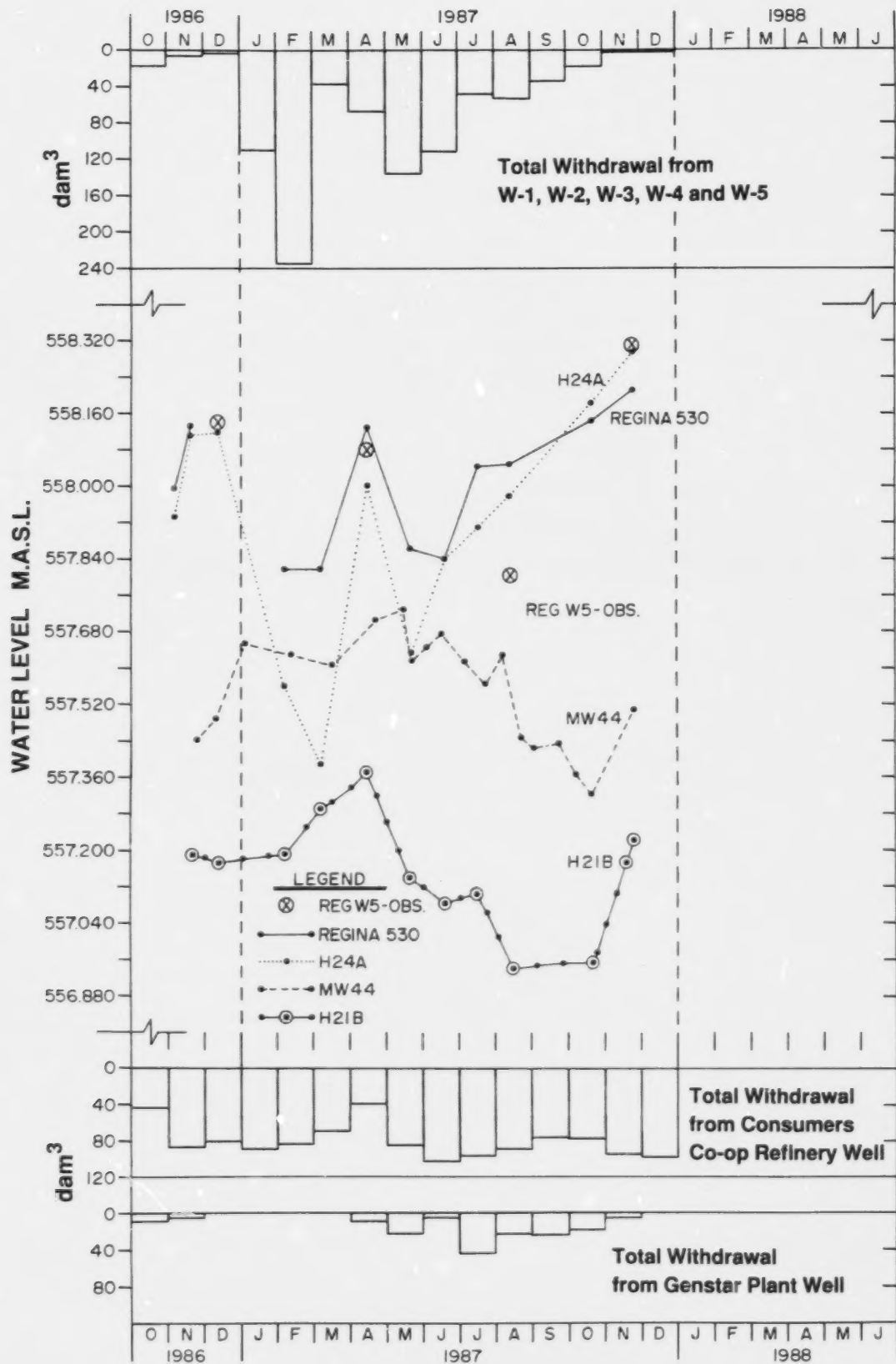


Figure 5.3-3 Monthly water level measurements and withdrawals for the Regina Aquifer, 1986-1987

from the continuous record of SRC Regina, and a few data points for W5-OBS. The locations of these piezometres are shown in Figure 5.3-4. Also shown in Figure 5.3-3 are the total monthly withdrawals for the western city production wells W1 to W5, the Co-op Refinery wells and the Genstar supply well.

The data plotted in Figure 5.3-3 show clearly that in the west, the drawdown cone due to pumping of wells W1 to W5 extends as far away as the observation well. However this drawdown cone disappears quickly when pumping from the wells ceases. The water level in piezometer H21B, north of the Co-op Refinery, clearly is correlated with withdrawals by the Refinery wells. The water level in MW44, at the northwest corner of the Landfill does not show as clear a response to pumping, either by the Co-op wells to the west or the Genstar well to the north.

The data plotted in Figure 5.3-3 show clearly that drawdowns due to pumping rapidly propagate through most of the north half of the aquifer. The "instantaneous piezometric surface" data, taken on April 14, August 12 and November 23, 1988 also show lower water levels in August for most of the aquifer, including the Interglacial Sediments. Relatively constant water levels were found only at the landfill site and in the far southwest of the aquifer (W2-20-16-31 and W2-21-16-36).

5.4 Groundwater Quality

Selected groundwater quality data for the Regina Aquifer are shown on Map No. 10 (Maathuis and van der Kamp, 1988a) and in Figure 5.4-1. The selected groundwater quality data used in the preparation of this map and figure are listed in Table 5.4-1. The complete data set is

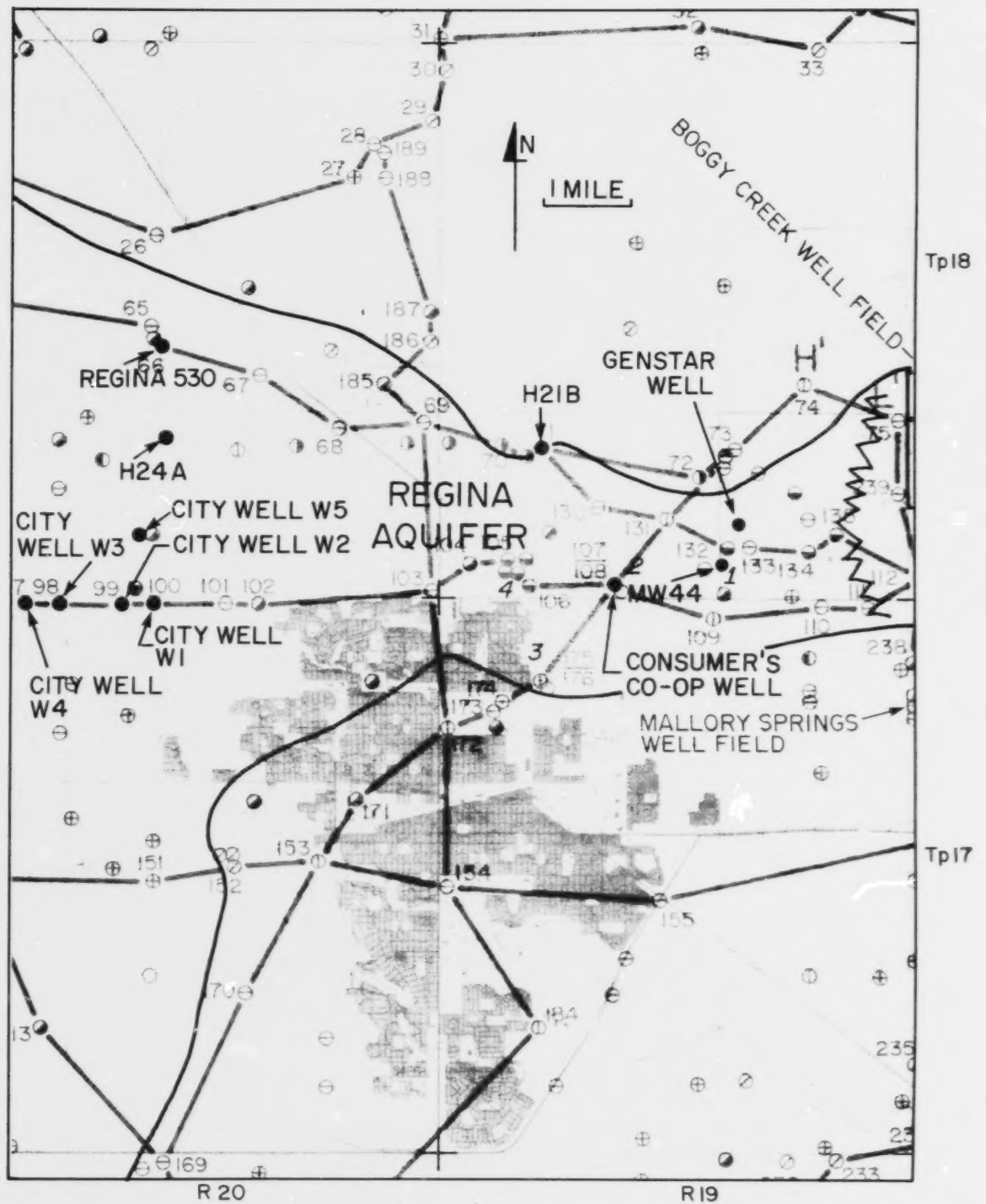


Figure 5.3-4 Locations of water level monitoring piezometers for the Regina Aquifer

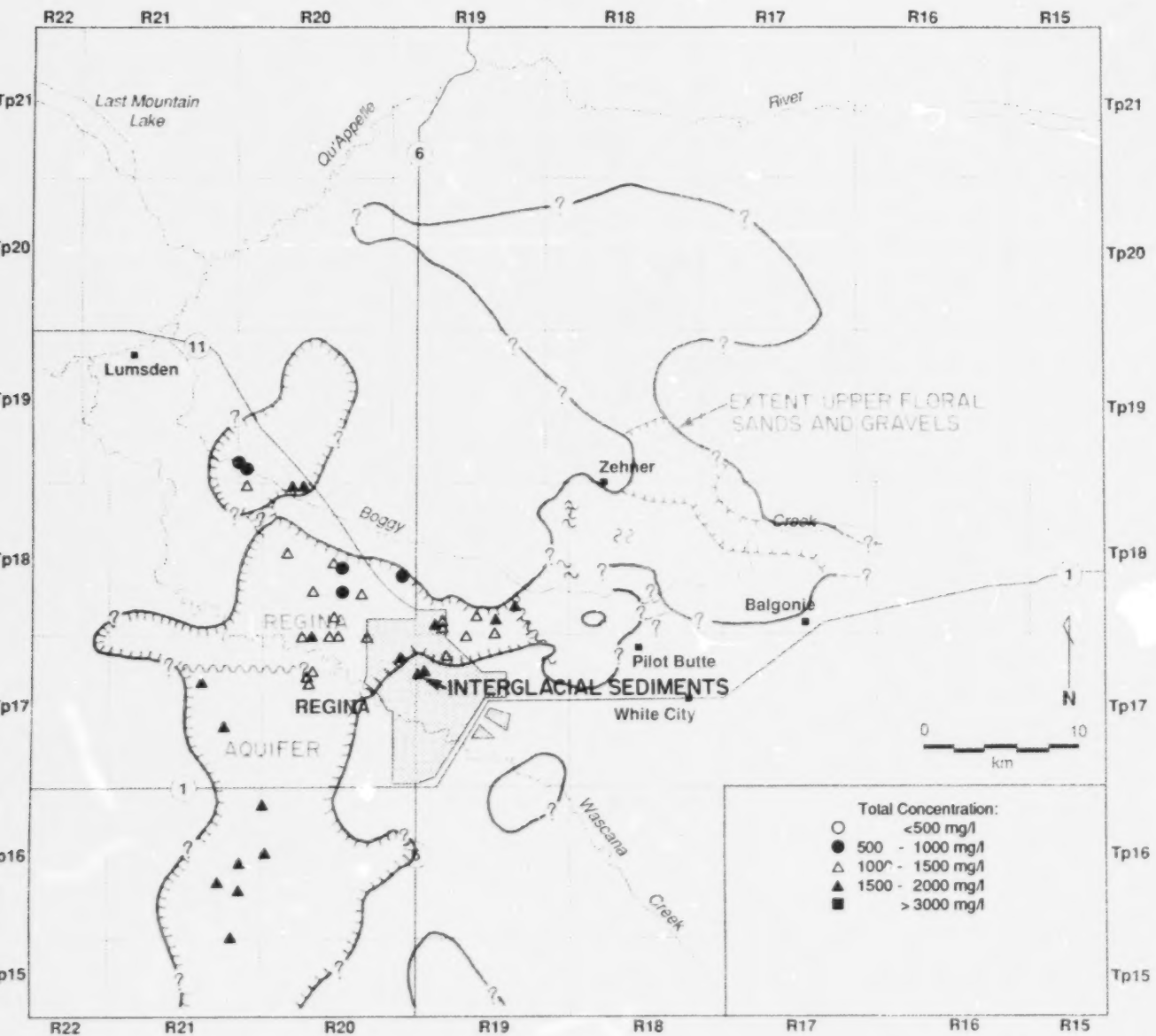


Figure 5.4-1 Distribution of total concentration in Regina Aquifer, based on selected groundwater quality data

TABLE 5.4-1 SELECTED WATER QUALITY DATA FOR THE REGINA AQUIFER

LAND LOCATION XX XX XX-XX-XX XX XX	WELL NAME	DATE YYMMDD	WELL ACQIT- DEPTH PER M	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	HCO3 MG/L	S04 MG/L	CL MG/L	NO3 MG/L	PO4 MG/L	F MG/L	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	ERROR BALANCE	REFERENCE	
W2 19 17 -30 12 SW 750212 CARLINE EA 60.4 ICS				7.32	157	90	126	9.0	5.00	0.43	577	557	14	0.2	0.10	0.35	1700	1536	760	473	1.24 SRC	CITY OF REGINA	
W2 19 17 30-12 SW 860722 REG. R8				7.60	157	102	134	1.60			573	570	24	<1				1562	812	470	-0.27 CITY OF REGINA		
W2 19 17 30-12 NW 850829 IO 4R				7.50	160	71	118	0.30	0.53		510	495	18	<1				1373	692	418	0.56 BECKIE, 1986		
W2 19-17 32 16 NE 850514 CAL 307				7.27	171	95	88	7.4	0.06	1.40	571	479	12	<0.02	0.02		(1)	1425	817	468	-1.73 CLIFTON, 1985		
W2 19 18 03 04 SW 750212 UH 72 1				7.25	168	79	81	7.0	4.60	1.34	530	467	7	3.5	0.02	0.50	1450	1349	745	434	0.28 SRC		
W2 19 18 03 12 SW 800200 TH 80				8.10	166	96	98	1.30	1.18		614	512	16	<1				1504	812	503	1.76 BECKIE, 1980		
W2 19 18 04 11 NW 850516 CAL 309				7.19	173	96	92	7.9	2.80	2.60	547	530	12	0.04	0.30		(1)	1464	826	448	-0.94 CLIFTON, 1985		
W2 19 18 06 01 SE 850829 MP 1B				7.20	165	86	92	2.30	1.90		572	480	14	<1				1363	764	428	-0.96 BECKIE, 1986		
W2 19 18 06 07 NE 850829 MP 3B				7.70	172	81	116	1.40	1.74		722	450	12	<1				1556	764	592	2.99 BECKIE, 1986		
W2 19 18 06 08 NE 850829 MP 4B				7.70	176	84	100	0.80	1.30		536	550	16	<1				1464	784	439	1.58 BECKIE, 1986		
W2 19 18 10 01 NW 810602 PW2 81				7.40	189	95	86	1.90	1.53		578	570	16	<1				1537	864	474	1.88 BECKIE, 1981		
W2 20-16 19 05 SW 871014 CREST				7.73	117	61	528	7.7	1.60	0.09	606	874	194	0.27	0.12		2960	2390	543	497	-0.61 SRC		
W2 20 17 22 16 SE 730403 KOMP				7.20	123	94	230	0.70	0.80		572	720	53	1.0				1795	596	469	4.02 MOLLARD, 1974		
W2 20-17 29 02 SE 741015 PRO TH14				8.20	27	130	87	84.00	0.50		261	525	10	<1				1125	604	214	-1.07 MOLLARD, 1974		
W2 20 17 29 07 NE 741015 PRO TH2-74				8.30	56	98	86	54.00	0.41		203	500	26	<1				1023	544	166	-0.44 MOLLARD, 1974		
W2 20 17 29 09 SE 741015 PRO TH3-74				8.00	74	97	86	70.00	0.55		244	500	38	<1				1110	584	200	0.22 MOLLARD, 1974		
W2 20 17 32 15 NW 860722 REG. W4				7.60	170	83	90	0.80	0.94		627	450	14	<1				1436	764	495	2.07 CITY OF REGINA		
W2 20 17 32-16 NE 860722 REG. W3				7.60	163	92	110	0.80	0.92		635	505	20	<1				1527	788	500	2.38 CITY OF REGINA		
W2 20 17 33 15 NW 840724 REG. W2				7.40	166	98	110	1.50	1.00		599	504	16	<1				1496	820	491	0.88 CITY OF REGINA		
W2 20 17 33 16 NE 860722 REG. W1				7.50	141	104	96	0.90	1.04		600	465	18	<1				1426	780	492	0.64 CITY OF REGINA		
W2 20 17 35 13 NW 830728 REG. W4				7.50	170	92	92	1.00	1.34		582	496	10	<1				1444	804	477	0.24 CITY OF REGINA		
W2 20 17 36 03 NW 860722 REG. R7				7.50	149	85	102	1.30	0.90		545	450	16	<1				1349	720	447	-0.30 CITY OF REGINA		
W2 20 18 04 09 NW 860722 REG. W5				7.50	136	80	100	1.20	0.49		592	380	14	<1				1304	668	485	0.82 CITY OF REGINA		
W2 20 18 09 NE 750211 HANLE				7.36	132	67	65	7.0	2.80	1.39	476	360	1	0.2	0.03	0.42	1230	1113	603	390	0.81 SRC		
W2 20 18 10 09 NW 831000 H13A				7.47	125	61	73	6.5	<0.1	1.10	476	265	13	<4		0.30	1220	1021	563	390	-3.17 REGINA, 1983		
W2 20 18 10 12 NW 831000 H24A				7.54	101	56	47	15.0	0.37	0.29	383	230	9	<4		0.58	900	842	482	314	-3.09 REGINA, 1983		
W2 20-18 13 06 SE 750211 IFS. 67 1				7.53	114	58	4	5.0	11.80	0.90	278	308	4	2.0	0.04	0.27	904	786	522	228	1.68 SRC		
W2 20 18 15 12 NW 830831 SRC R 530				7.74	90	31	12	4.1	0.43	0.55	292	112	14	<0.2	<0.03	0.10	661	556	351	239	0.99 SRC		
W2 20 " " 16 16 SE 871014 MORGAN				7.61	172	62	69	6.9	3.20	0.99	427	452	11	0.03	<0.03	0.40	1280	1204	683	350	0.42 SRC		
W2 20 18 19 01 NE 750212 FROHER				7.30	138	60	64	7.0	3.00	0.97	456	361	<1	0.1	0.03	0.40	1240	1061	591	374	0.77 SRC		
W2 20 18 32 13 SW 871022 CONDO. CULV.				7.85	364	170	176	9.8			374	1490	112			2930	2716	1660	306	-0.91 SRC			
W2 20 18 32 15 NW 871013 MCLEUD				7.63	267	122	115	9	0.59	0.70	486	940	35	1.7	<0.03		2120	1977	1170	388	0.07 SRC		
W2 20 19 06 07 N 871022 GOLF SPR.				8.23	83	63	71	7.9			290	354	9.3			1030	877	466	237	-0.81 SRC			
W2 29 19 06 13 SW 871022 TROUT POND				8.17	99	66	77	6.8			338	370	10			1140	967	517	278	1.34 SRC			
W2 21 16 02 01 SW 871014 GANSHORN				7.45	121	468	10	1.00	0.84		654	1220	109	<0.02	<0.03		3150	2785	997	536	1.76 SRC		
W2 21 16 12 13 NW 871014 SELBY				7.63	153	79	288	7.6	0.28	0.90	623	707	46	0.09	0.12		2190	1905	708	511	1.17 SRC		
W2 21 16 14 SW				122	95	239					622	623	40					1741	616	510	0.01 RUTHERFORD, 1966		
W2 21 16 24 04 SW 871015 BAKIL				7.35	174	125	196	11	0.32	1.80	642	1270	34	<0.02	<0.03		2700	2654	1140	527	0.22 SRC		
W2 21 16 36 08 SE 871014 GANSHORN				7.69	158	114	168	9.4	0.35	0.65	602	681	20	0.04	0.15		1910	1754	861	494	0.40 SRC		
W2 21 17 14 06 SE 750213 FANLEY				7.31	109	51	279	8.0	5.00	0.11	582	564	7	6.1	0.03	0.38		1780	1612	482	477	-0.87 SRC	
W2 21 17 27 02 SE 871015 LIPSEY				7.61	140	76	212	8	4.10	0.09	527	574	42	0.02	0.12		1830	1583	653	432	2.00 SRC		
W2 21 18 36 14 NW 871013 PETERS				7.70	136	84	92	6.7	1.10	0.77	505	431	10	0.09	0.06		1420	1267	686	414	0.94 SRC		

given in Appendix D (major ions plus iron and manganese).

Organics and heavy metals are not included in this data set. The recent report by Golder Assoc. (1987) provides detailed information on these constituents.

Groundwater in the Regina Aquifer ranges in total concentration from 550 to 2800 mg/L, but typically is in the 1000 to 1500 mg/L range. The water quality for a well at W2-20-18-13-06-SE is unusual for water quality in Upper Floral aquifer zones. This well yields water with a total concentration of 786 mg/L, but both in an absolute and relative sense has a low sodium concentration and high iron content. The well is located in a geologically complex area, and may have been completed in an isolated aquifer zone.

In terms of water type, groundwater in the Regina Aquifer is of the Ca/Mg - SO_4 , Ca/Mg - HCO_3 , and Ca - SO_4 type. The distribution of the water types is erratic and at present insufficient data area available to distinguish any major regional patterns. The water type is determined by the relative concentrations of sulphate and bicarbonate. Compared to water in the Condie Aquifer, which recharges the Regina Aquifer, water in the Regina Aquifer appears to have a slightly higher relative concentration of sodium and potassium. This possibly may be due to cation exchange in the aquitard separating these aquifers. The two analyses available for the Interglacial Sediments show a water quality similar to that of the nearby Upper Floral sands, though with a slightly higher relative concentration of sodium and potassium.

In the far south west of the aquifer some relatively poor water qualities have been encountered with sum of ions up to 2735 mg/l, and

relatively high sodium and chloride content. These probably reflect natural very slow flow of the groundwater.

In assessing the water quality data for aquifers such as the Regina Aquifer the possibility of vertical zonation of water quality must be born in mind. An indication of such zonation was encountered at the observation well SRC Regina 530 (W2-20-18-15-12-NW) and a nearby farm well (Morgan). The depths of the two wells are 38.3 and 45.7 metres respectively and the sum of ions are 556 and 1204. In this part of the aquifer there may well be vertical inflow of good quality water from the overlying Condie Aquifer.

Dissolved iron and manganese in the water present a manageable but costly problem with regard to drinking water supply. There appears to be significant spatial as well as temporal variations in the reported iron and manganese concentrations (see Table 5.3-1). However, it generally has not been documented whether or not water for iron and manganese determinations was filtered in the field prior to acidification. Consequently, the significance of the reported variations cannot be properly assessed.

The best water qualities, as shown by the sum of ions values, are encountered along the north boundary of the aquifer, in Range 20 Township 18. This relatively good water may be a reflection of the vertical inflow of good-quality water from the overlying Condie Aquifer.

It is noticeable that the western wells W1 to W5 have relatively poorer quality of water as compared with other wells to the north and south. This may be a matter of well depth and perhaps of inflow from the underlying Interglacial Sediments.

Surface water samples taken from reservoirs fed by spring inflow along the south side of the Boggy Creek Valley (W2-20-19-6) are consistent with water quality encountered in the Regina Aquifer to the south (see Table 5.4-1: W2-20-19-06-07-N and W2-20-19-06-13-NW). A spring discharge sample taken on the north side of the Boggy Creek just downstream from the Condie Reservoir (Condie Culvert, W2-18-32-13-SW) shows much poorer water quality, presumably reflecting hydrologic conditions in the far north-western part of the aquifer. It should be noted that the springs further north in the Flying Creek watershed were reported to have water qualities with total concentrations in the 1500 parts per million range (Hill et al, 1930, p. 34, Cooper Spring and Dickson Spring).

For all the City of Regina production wells completed in the Regina Aquifer, the R and W wells, repeat analyses are available since 1980. For wells W2 to W6 a 1966 analysis is also available (Mollard, 1966). No information is available on the consistency of sampling procedures, sampling points, and sample preservation and handling. It is therefore not clear whether the small increase of chloride concentration since 1966 for wells W1 to W4 is reliable. These chloride values could be an indication of a natural water quality change. They could also indicate contamination, perhaps by infiltration from Wascana Creek, which has chloride concentration of a few hundred mg/L downstream from the sewage treatment plant.

During 1987 selected groundwater samples from the Regina Aquifer were analyzed for tritium content. The results of these analyses are given in Table 5.4-2. Since the samples showed no detectable levels of

TABLE 5.4-2 TRITIUM CONCENTRATION IN WATER FROM REGINA AQUIFER

SAMPLE WELL	LOCATION	SAMPLE DATE	TRITIUM (T.U.)	DESCRIPTION
=====				
MW44	W2-19-18-03-05-SW	30/03/87	<0.8 +/- 0.7 1.4 +/- 0.8	SW CORNER ACTIVE LANDFILL
MW47	W2-19-18-03-13-NW	30/03/87	<0.8 +/- 0.7	NORTH OF LANDFILL
MW59	W2-19-18-04-08-SW	30/03/87	<0.8 +/- 0.6 <0.8 +/- 0.6	WEST OF LANDFILL
IO-4B	W2-19-17-32-04-NW	30/03/87	<0.8 +/- 0.7	FORMER IMPERIAL OIL SITE
MP2B	W2-19-18-06-02-NE	04/05/87	<0.8 +/- 0.7	NEAR MOUNT PLEASANT LANDFILL
=====				

NOTE: DATA SUPPLIED BY CITY OF REGINA PUBLIC WORKS AND ENGINEERING
DEPARTMENT

tritium, it is concluded that most of the water infiltrated prior to 1953.

5.5 Hydraulic Properties

Pumping tests for the Upper Floral Sands and Gravels and the Interglacial Sediments of the Regina Aquifer have been described in various reports. The transmissivities obtained from these tests are summarized in Table 5.5-1. Storage coefficients have not been tabulated since these are generally unreliable.

The Upper Floral Sands and Gravels of the Regina Aquifer mostly have high transmissivities, averaging $1.5 \times 10^{-2} \text{ m}^2/\text{sec}$ ($1260 \text{ m}^2/\text{day}$). The Interglacial Sediments appear to have lower transmissivities, in the range of $6 \times 10^{-4} \text{ m}^2/\text{sec}$ ($50 \text{ m}^2/\text{day}$). These transmissivities have been calculated by curve matching techniques applied to drawdown data obtained from nearby observation wells. The individual values should not be considered as reliable to within a factor of two. It is clear that most of the Regina Aquifer has relatively high permeability. Some of the pumping tests show boundary effects which indicate the presence of less permeable zones within the aquifer. Possibly the most permeable parts are in the form of channel deposits embedded within less permeable sands.

5.6 Groundwater Regime

The water-level data (see Sections 5.2 and 5.3) show that the piezometric surface of the Regina Aquifer is relatively "flat" and has always been flat even though the average hydraulic head has decreased by

TABLE 5.5-1 REGINA AQUIFER: TRANSMISSIVITIES FROM PUMP TESTS

AREA	LOCATION	WELL NO	SOURCE OF DATA	TRANSMISSIVITY (M2/SEC)
=====				
REGINA AQUIFER (1)	W2-19-18-03-SE	TH2-BR60	LISSEY 62	4.4E-3
REGINA AQUIFER (1)	W2-19-18-10-01-NW	PW1-81	BECKIE 81	3.5E-2
REGINA AQUIFER (1)	W2-20-17-22-NE	RCMP PW3-73	MOLLARD 73	1.3E-3
REGINA AQUIFER (1)	W2-20-17-27-NW	TH4-H61	LISSEY 62	1.6E-2
REGINA AQUIFER (1)	W2-20-17-32-15-NW	W4	JACKSON 64	1.6E-2
REGINA AQUIFER (1)	W2-20-17-33-16-NE	W1	JACKSON 64	1.3E-2
REGINA AQUIFER (1)	W2-20-17-34-NW	TH4-H6	LISSEY 62	1.6E-2
REGINA AQUIFER (1)	W2-20-17-35-15-NW	W2	JACKSON 64	1.8E-2
REGINA AQUIFER (1)	W2-20-18-06-SE	TH11-BR61	LISSEY 62	1.1E-2
REGINA AQUIFER (1)	W2-20-18-08-NE	TH96-BR60	LISSEY 62	1.7E-3
REGINA AQUIFER (1)	W2-21-16-25-NE	SPC WELL	MOLLARD 65	1.3E-2

REGINA AQUIFER (2)	W2-20-17-24-NW	TH1-P61	LISSEY 62	9.4E-4
REGINA AQUIFER (2)	W2-20-17-26-NE	TH8-BR60	LISSEY 62	2.4E-4
=====				

NOTES: (1) MEANS UPPER FLORAL SANDS AND GRAVELS
 (2) MEANS INTERGLACIAL SEDIMENTS

5 to 6 metres since about 1940. This flatness implies considerable hydraulic continuity throughout the aquifer, despite the relative vertical displacements of the aquifer zones as encountered in different test holes.

The decline of static water level means that individual well yields have also decreased correspondingly, due to the smaller available drawdown. Depending on the depth of the wells, the decrease of yield could be anywhere from 10 to 50 percent.

The high transmissivity of about $10^{-2} \text{ m}^2/\text{sec}$ (see Section 5.5) together with the continuity and thickness of the overlying aquitard mean that drawdown "cones" around pumping wells are shallow and very flat, extending out to distances of 5 kilometres and more. It is this property of the aquifer-aquitard system which causes the flatness of the piezometric surface in the aquifer. The large extent of the drawdown cones also means that all the production wells in the Regina Aquifer should be considered as mutually interfering to various degrees.

The aquifer is under water-table conditions over part of its area. Thus it has a large active storage capacity (yield per unit drawdown) which will further tend to reduce the magnitude of drawdowns near production wells. The area with water-table conditions has increased over the years as the water-levels declined, and the storage capacity has increased proportionally.

The water-level data collected over the years are limited, but do show that the average head in the aquifer decreased relatively rapidly between about 1940 and about 1975 or 1980. It seems that for the past 10 years or so there may not have been much over-all decline, indicating

that the present level of withdrawals plus discharge is balanced by the recharge into the aquifer. However, the large active storage capacity of the aquifer means that much of the water being withdrawn may still be coming from storage. The associated long-term water-table decline might be only a metre in 10 years and would not be clearly identifiable given the shortage of historical water-level data.

The hydraulic head data for the Regina Aquifer, as plotted on Map No. 9 (Maathuis and van der Kamp, 1988a) clearly show a permanent drawdown cone centred on the Co-op Refinery wells and nearby City wells. There is a clear indication of lateral recharge into the aquifer north of the landfill site. There is also a gradient from the northwest towards the centre of the aquifer indicating that recharge is probably occurring in the northwestern part of the aquifer, but a part of this flow could also originate from storage of water within the aquifer. The head in the aquifer is almost everywhere below the bottom of Wascana Creek, so that discharge from the aquifer to the creek is practically excluded, but there may be some recharge from the creek. In fact the lack of a permanent drawdown cone around the western wells W1 to W5 suggests strong recharge in the vicinity of the wells, either from the overlying Condie Aquifer or from Wascana Creek, or both.

At present the hydraulic gradients in the south-western "lobe" of the aquifer (Ranges 20 and 21, Township 16 and 17) are very small. Historical water-level data for this part of the aquifer are very limited (see Appendix B) and do not give a clear indication as to whether water levels in this part of the aquifer have declined over the years.

The relatively good water qualities encountered along the northern part of the aquifer in Range 20, Township 18, are indicative of recharge from the overlying Condie Aquifer. However the accurate water-level data from the "instantaneous piezometric surface" program show little "mounding" of the piezometric surface. If recharge is occurring, as is likely, it must be diffuse over a relatively large part of the aquifer.

The springs on the south side of the Boggy Creek valley in W2-20-19-6, appear to be discharging from the Regina Aquifer. The elevation of the Boggy Creek valley at this point is about 550 to 555 m above sea level. The existence of springs at this elevation is therefore consistent with the hydraulic head in the Regina Aquifer to the south which is in the range of 555 to 559 m above sea level. Probably the flow from these springs was larger in the past when the head in the Regina Aquifer was higher. At present the flow is estimated to be in the range of 500 to 1000 dam³/year.

5.7 Water Balance

Water levels in the Regina Aquifer have declined by 5 to 6 metres over the past 50 years or so. This decline shows that over this period withdrawals plus continuing discharge have exceeded recharge. However, during the past decade the water levels appear to have levelled off. Average yearly withdrawals from the Regina Aquifer from 1978 to 1987 were 4300 dam³ per year, and the recharge may be of about the same magnitude. However the apparent "levelling off" of the water levels may also be largely due to the increase of active storage (yield per unit decline of head) as more and more of the aquifer comes under water-

table conditions.

Estimates of water balance components, averaged over the 10 year period 1978-1987, for the Regina Aquifer can be summarized as follows:

(1) Recharge	
(a) lateral flow from the east	1000 to 1500 dam ³ /yr
(b) from Condie Aquifer	800 to 1800 dam ³ /yr
(c) infiltration from ground	1000 to 1500 dam ³ /yr
(d) from Wascana Creek	500 to 1000 dam ³ /yr
(e) from surface impoundments	0 to 100 dam ³ /yr
Total Recharge	4400 to 4900 dam ³ /yr
(2) Discharge and Withdrawals	
(a) to withdrawals	4300 dam ³ /yr
(b) to Boggy Creek	500 to 1000 dam ³ /yr
(c) to Wascana Creek	0 to 100 dam ³ /yr
Total Discharge	4800 to 5400 dam ³ /yr
(3) Net Change in Storage	-100 to 1000 dam ³ /yr

The volumes of water per year listed in the above summary represent estimates of the probable range of values.

With respect to recharge, the amount of lateral flow from the east is estimated from the measured hydraulic gradient and transmissivity in the area of the landfill. The component from the Condie Aquifer represents all recharge to the central and western parts of the Condie Aquifer, including recharge from ponds and gravel pits in the western part of the Aquifer. It is assumed that all discharge from the Condie Aquifer is to the Regina Aquifer. Infiltration from the ground has no doubt been much influenced by urbanization, involving recharge from water mains and sewer pipes, lawn watering, removal of vegetation, etc. The downward hydraulic gradient to the aquifer is near-unity over most of the aquifer area, thus a permeability as low as 10^{-9} m/sec would still give a recharge rate of 3 cm/year. Inflow from Wascana Creek may

be significant since the aquifer piezometric surface is below the water level of the creek except in the very western part of the aquifer. In the west the aquifer comes up close to the creek bottom (see Cross-section E - E') and at least some hydraulic connection of the creek and the aquifer is likely. Finally, man-made surface impoundments such as sewage lagoons provide an additional small recharge component. Total recharge is estimated to be in the range of 4400 to 4900 dam³ per year. Discharge from the Regina Aquifer during the period 1978 to 1987 was almost entirely by withdrawals from wells. There is however a significant discharge to the springs in the Boggy Creek valley in W2-20-19-6 and there may be some minor discharge to Wascana Creek at the western edge of the aquifer where the creek level drops below 558 m. The total discharge plus withdrawals lies in the range of 4800 to 5400 dam³/year.

The amount of water taken from storage in the aquifer may be anywhere from -100 to 1000 dam³/year. The total active storage capacity of the aquifer depends on the area under water-table conditions, which for the 1987 water level is about 20 to 50 km². The corresponding storage capacity for a specific yield of 0.20 is 4000 to 10,000 dam³ per metre of drawdown. The water level data show that total drawdown over the past 10 years has been at most a metre, and therefore the water removed from storage could have been at most about 1000 dam³ per year. This limit is reflected in the foregoing estimates which reflect an approximate balance between recharge and discharge.

It is worth while to consider what conditions would have been like before major withdrawals began, say around 1900. At that time the higher water levels in the aquifer would have meant greater discharge

and less recharge, with the two balanced out at about 1000 to 2000 dam³/year. Most of the discharge was probably at the location of presently flowing springs in the Boggy Creek valley with some discharge to Wascana Creek.

The relatively rapid decline of water levels after 1940 presumably reflected an excess of discharge plus withdrawals over recharge, combined with a lower storage capacity since at that time very little of the aquifer would have been under water-table conditions.

It is worthwhile to consider for a moment what might happen if withdrawals from the Regina Aquifer would cease. The groundwater levels would then rise until minor discharge to Wascana Creek and major discharge to Boggy Creek would be restored. Such a rise in hydraulic head and an accompanying rise of the water table above, could lead to problems such as moist basements, ground instability and reappearance of contaminants such as gasoline which tend to "float" on the water table. Such problems might in fact be negligible, but should be considered if it were proposed to stop pumping. In effect the Regina Aquifer functions as a deeply buried drain under the city area, pumped out by the production wells.

5.8 Susceptibility to Contamination

On the whole the Regina Aquifer is well protected from contamination by a thick overlying aquitard of clay, silt and till. The efficiency of this low-permeability cover in preventing downward movement of contaminants to the aquifer has been shown by the work done at the Federal Pioneer PCB spill site (National Research Council of Canada 1980;

Anderson and Pankow, 1986).

The principal potential pathways for contamination of the Regina Aquifer are (a) with inflow from Condie Aquifer (b) from Wascana Creek and (c) via improperly sealed drill holes and wells, including holes drilled for piles.

The possibility of contaminated water from the Condie Aquifer entering the Regina Aquifer is of concern because contaminants have been found in the Condie Aquifer, particularly in the central part of the Aquifer. The thickness of the till separating the two is shown on Map No. 4 (Maathuis and van der Kamp, 1988a) and in Figure 2.8-1. The till has been encountered in all the drilled holes, but with thickness varying from 2.7 to 26.2 metres. The head difference across the till ranges from about 5 metres in the west to over 20 metres in the landfill area. Downward hydraulic gradients are as high as 2.0 or 3.0 for the thinner parts of the till. Such gradients could lead to downward flow velocities of up to a metre or more per year, depending on the vertical hydraulic conductivity of the till. It is interesting to note that estimated total vertical flow to the Regina Aquifer from the central part of the Condie Aquifer, 600 to 1200 dam^3/year , gives an average downward flow rate of about 1.5 to 3.0 cm per year (assuming an area of about 40 km^2), and an average downward velocity of 6 to 12 cm per year, assuming an effective porosity of 0.25. The flow rates in the thinnest parts of the till would be considerably higher than these averaged values. Thus water from the Condie Aquifer may require only a few years to reach the Regina Aquifer. Leaking well casings, unplugged test holes, or possible "gaps" in the till would of course constitute even

faster pathways for water movement. It is clear therefore that the till separating the two aquifers cannot be relied upon as a long-term barrier preventing contaminants in the Condie Aquifer from reaching the Regina Aquifer.

It is not possible to predict when and where contaminants from the Condie Aquifer might show up in water that is pumped from production wells in the Regina Aquifer. Due to dilution and dispersion the concentration levels of such contaminants would tend to increase only very slowly and would tend to remain very low unless a production well happens to be very near a strong local leakage point such as a leaking well-casing. As mentioned in section 6.6, the hydraulic head data for the Regina Aquifer suggests that most of the recharge from the Condie Aquifer occurs diffusely over a wide area. However, small localized leakage points would not be easily detected by means of hydraulic head data.

There is a distinct possibility that water is flowing into the Regina Aquifer from Wascana Creek in the general vicinity of the sewage treatment plant. Hydraulic connections between the aquifer and the creek have not been positively identified, but are probable in view of the relatively shallow occurrence of the top of the aquifer in parts of this area. The discharge from the treatment plant is relatively high in chlorides due to water softening. A recharge plume could therefore be readily identified if it reaches a well or piezometers. The slight trend to increasing chloride concentrations in the City's production wells W1 to W4 could be an indication of such inflow from Wascana Creek. However, these could be due to changes in sampling and analysis methods,

and could also reflect flow of water from the underlying Interglacial Sediments. In any case, recharge of effluent water to the aquifer may not be of serious concern with regard to water quality standards and could even be beneficial in maintaining aquifer yield.

Leakage of contaminants into the aquifer via improperly sealed drill holes and wells is of concern within the urban-industrial area where contaminants are likely to occur at many places near ground surface. In addition, wells completed in the aquifer have probably been used for disposal of wastes and surface waters, at one time or another.

J.D. Mollard and Assoc. (1960, p. 12) stated that both the Consumers' Co-operative Refinery and the Imperial Oil Refinery used such wells, the former well still being in use at the time of the 1960 report.

Contaminants from such sources would probably reach production wells at much diluted and slowly increasing levels. Regular monitoring of the water quality would detect such contaminants before they would reach undesirable levels.

6 GROUNDWATER RESOURCES OF THE ZEHNER AQUIFER SYSTEM

6.1 Definition and Extent of the Zehner Aquifer System

As discussed in Chapter 2, the geology in the area of the Boggy Creek well field and immediately north, south and east of it is complex. With the available data it is not possible in much of the area to establish the stratigraphic identity and continuity of the aquifer zones. However, the water level data and the proven long-term yield of the Boggy Creek and Mallory Springs wells leave no doubt that there must be excellent hydraulic continuity. Further to the east and north (Township 18, west half of Range 17, east half of Range 18) the Upper and Lower Floral Formations can be identified with reasonable certainty (Maathuis and van der Kamp, 1988a: Maps 4 and 6). However, the water-level data show that there is a strong hydraulic interaction between the units in this area. Water level data also indicate a strong hydraulic interaction between this area and the Boggy Creek - Mallory Springs well field area.

Considering the geologic complexity and hydraulic interactions, it appears reasonable to treat the aquifers formed by the Upper and Lower Floral sands and gravels and the aquitards formed by the related till units as one complex aquifer system rather than individual aquifer units. The extent of this complex aquifer system, which will be referred to as the Zehner Aquifer System, is shown in Figure 6.1-1. It extends from the hydraulic discontinuity in the east half of Range 19, Township 18 to the full extent of the Upper or Lower Floral aquifer zones in Ranges 17 and 18, Township 18 and north half of Township 19. The northern boundary of the system is somewhat arbitrarily taken as

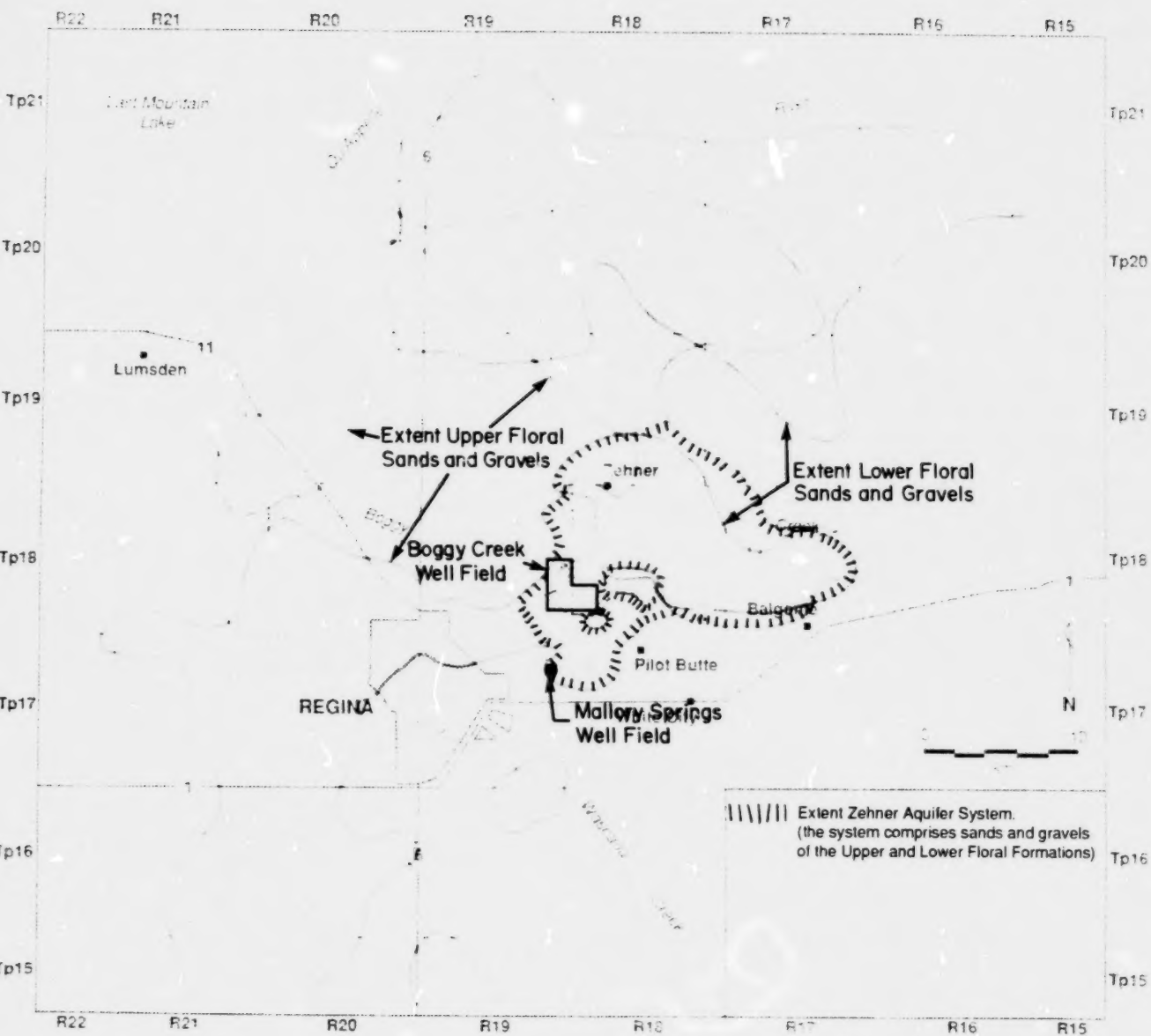


Figure 6.1-1 Extent of the Zehner Aquifer System

halfway Township 19 on the assumption that this is the approximate location of the groundwater divide between water flowing south and water flowing north.

6.2 Piezometric Surface

Water level data for the Zehner Aquifer system are given in Appendix B. Selected water level data are shown on Maps 9 and 11 (Maathuis and van der Kamp, 1988a). Very few accurate data points are available, but an overall pattern can be discerned.

The most important point with respect to piezometric data is the "flatness" of the piezometric surface within all but the far eastern part of the Lower Floral aquifer zones. Virtually all the data points lie between 595 and 615 metres with no clearly discernible trend. Since the land surface rises steadily to the northeast this flat piezometric surface means that in the northern part of the system the static water levels are up to 50 and 60 metres below ground level, with often only a few metres of water in the wells.

The great depth of the static water levels below ground, coupled with the "flatness" of the piezometric surface, are a strong indication that the Lower Floral aquifer zones are hydraulically connected by highly permeable aquifer zones. These continuous zones constitute an effective horizontal drain at the base of the aquifer system. The entire system discharges to what used to be flowing springs and are now wells in the Boggy Creek and Mallory Spring well fields. The static water levels in these well fields have ranged between 580 and 600 metres over the years, depending on the degree of pumping. These production

well levels are slightly lower than the levels in the Lower Floral Aquifer zones and are thus entirely consistent with the picture of flow from the north and east.

Static water levels in the Upper Floral sands and gravels, where they are not dry, are generally considerably higher than the levels in the underlying Lower Floral sands (Maathuis and van der Kamp, 1988a: Map No. 7). These data are thus consistent with the conceptual model of vertical flow to the Lower Floral sands and lateral drainage through these sands. However, a stronger indication of this flow pattern lies in the fact that the Upper Floral aquifer zones are dry or virtually dry over much of the area of the aquifer system. In other words, these must be very effectively drained by downward flow to the Lower Floral sands.

6.3 Groundwater Quality

Selected groundwater quality data for the Zehner Aquifer System are summarized in Table 6.3-1 and are shown in Figure 6.3-1. These data are also plotted on Map Nos. 10 and 12 (Maathuis and van der Kamp, 1988a).

The major ion concentrations for these groundwater samples are typical of relatively good quality water from glacial drift aquifers in southern Saskatchewan. The sum of ions lies in the range 405 to 1955 mg/L, averaging about 1000 mg/L. The water is of calcium bicarbonate type. Relatively high sulfate levels are associated with the higher total concentrations. This water type and water quality is indicative of fairly strong recharge, either into surficial aquifers (which would give low sulfate levels) or through leached depressions in clayey materials, (which would lead to moderate sulfate levels).

TABLE 6.3-1 SELECTED WATER QUALITY DATA FOR ZEHNER AQUIFER SYSTEM

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH FEET	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	PO4 MG/L	P US/CM	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	ERROR BALANCE %	REFERENCE
W2 17-18 07-16	NE 861103	BALCONIE	36.8 U.FL.	7.71	81	32	9.8	4.5	<0.01	<0.01		326	77	4	3.1	0.03	0.28	627	538	336	267	-0.63 SRC
W2 17 18 10 05	SE 871016	STIEPEL	39.9 U.FL.	7.57	167	54	10	7.3	0.15	<0.01		474	197	30	70.8	0.06		1070	1010	637	389	1.70 SRC
W2 17 18 16 02	SW 861028	GRAY	38.1 U.FL.	7.14	184	88	54	7.8	9.40	1.00		610	419	7	0.2	<0.03	0.32	1440	1381	816	500	-0.08 SRC
W2 17 18 22 14	NE 871016	HUBER	68.9 L.FL.	7.59	104	42	42	6	2.20	0.57		471	114	4.1	0.09	<0.03		830	786	431	836	-1.99 SRC
W2 17 18 31 08	SE 871015	KUCH	47.2 U.FL.	7.42	168	112	63	6.6	0.15	0.91		544	543	3.4	<0.02	<0.03		1580	1441	882	446	0.46 SRC
W2 18 17 29 13	NW 850319	PM1-85	54.0 U.FL.	7.30	85	42	35	0	0.10	0.97		357	140	6	1.0			667	384	293	1.47	BECKIE, 1985
W2 18 17 30 02	SW 861028	HORRINS	45.7 U.FL.	7.25	227	81	108	9.2	4.30	1.40		392	761	25	0.04	<0.03	0.28	1730	1609	900	321	0.14 SRC
W2 18 17 30 13	NW 861028	ZINGHAM	51.7 U.FL.	7.35	96	43	37	5.3	4.00	0.94		387	180	4	0.1	0.06	0.30	828	758	418	317	0.74 SRC
W2 18 18 07 07	NE 860400	REG. G1W3	19.3 N/D	8.10	45	38	10		1.00	0.01		222	75	24	<1			415	268	182	0.60	BECKIE, 1986
W2 18 18 07 07	NE 860400	REG. G1W4	20.6 N/D	7.20	82	34	11		<0.1	0.67		317	86	16	<1			547	344	260	0.47	BECKIE, 1986
W2 18 18 07 07	NW 860500	REG. R1W7	60.8 N/D	7.60	91	32	29		0.10	0.40		288	178	4	<1			623	360	235	0.61	BECKIE, 1986
W2 18 18 07 07	NW 860400	REG. G1W1	12.8 N/D	7.80	83	28	15		0.20	0.03		302	93	20	<1			541	324	248	2.42	BECKIE, 1986
W2 18 18 07 07	NW 860400	REG. G1W2	18.0 N/D	7.80	85	32	11		0.10	0.02		317	85	20	<1			550	344	260	1.19	BECKIE, 1986
W2 18 18 07 07	NW 860400	REG. G1W5	17.4 N/D	8.10	85	35	14		<0.1	<0.01		319	80	16	<1			549	356	261	2.55	BECKIE, 1986
W2 18 18 07 09	SE 860722	REG. BC-6	68.9 N/D	7.50	128	65	40		<0.1	0.75		461	274	8	<1			977	588	378	0.04	CITY OF REGINA
W2 18 18 07 15	NE 860722	REG. BC-5	57.9 N/D	7.50	165	81	56		<0.1	0.81		535	392	8	<1			1238	744	439	0.51	CITY OF REGINA
W2 18 18 07 15	NE 860000	REG. P60	57.9 N/D	7.30	169	74	50	8.0		1.80		499	380	7				1189	703	409	1.84	MILLARD, 1966
W2 18 18 09 05	NE 861029	THOMAS	21.9 U.FL.	7.31	87	26	17	4.5	0.03	0.72		335	79	4	<0.02	0.09	1.70	598	555	324	274	0.04 SRC
W2 18 18 10 16	NE 770510	ONS. #6	23.5 L.FL.	8.20	34	41	11		1.50	0.01		273	40	4				405	252	224	1.15	BECKIE, 1977
W2 18 18 12 16	SE 861029	SYRITA	24.1 U.FL.	7.56	73	26	8.1	4.6	0.04	<0.01		299	53	4	8.4	<0.03	0.23	521	476	288	245	0.11 SRC
W2 18 18 20 01	SW 861029	BURSHOCK	51.8 L.FL.	7.32	77	26	7.4	3.8	0.23	0.06		309	54	4	8.9	<0.03	0.20	530	491	301	253	0.43 SRC
W2 18 18 21 13	NW 861104	ADAR	65.2 L.FL.	7.34	205	107	79	9.0	3.60	1.10		603	618	8	0	<0.03	0.31	1750	1634	954	494	0.64 SRC
W2 18 18 21 14	NE 750212	BRIDOT	53.6 L.FL.	7.20	163	81	41	7.0	3.78	1.50		569	357	4	0.4	<0.01	0.42	1250	1228	737	466	0.42 SRC
W2 18 18 24 14	SW 861028	WARD	59.7 L.FL.	7.20	277	89	134	11.0	0.47	0.65		599	834	10	0	<0.03	0.28	2000	1955	1060	491	0.41 SRC
W2 18 18 26 08	NE 861028	CRUSON	70.1 L.FL.	7.21	158	62	27	5.9	4.30	0.96		494	291	3	0.1	<0.03	0.25	1110	1047	649	405	0.19 SRC
W2 18 18 29 09	SE 861028	DEGELMAN	47.2 L.FL.	7.13	246	113	67	7.9	0.88	2.20		641	666	8	0.1	<0.03	0.27	1780	1752	1080	525	0.15 SRC
W2 18 18 34 13	SW 861028	CRUSON	64.0 L.FL.	7.22	229	97	70	5.8	0.07	3.10		618	579	7	0.1	<0.03	0.22	1650	1609	970	506	0.46 SRC
W2 18 19 05 03	SW 861028	HROWN	47.2 L.FL.	7.15	206	87	38	7.1	0.36	2.10		517	489	15	6.2	<0.03	0.27	1440	1368	873	424	0.20 SRC
W2 19 17 25 12	NW 860722	REG. K1	42.4 U.FL.	7.60	115	62	46		0.50	0.81		445	250	14	<1			933	544	365	0.21	CITY OF REGINA
W2 19 17 25 12	NW 860722	REG. P1	42.7 U.FL.	7.60	117	61	45		<0.1	0.86		444	250	8	<1			926	544	364	0.41	CITY OF REGINA
W2 19 18 12 07	NE 860722	REG. BC-38	48.8 N/D	7.40	118	59	41		<0.1	0.64		441	248	10	<1			918	540	362	0.59	CITY OF REGINA
W2 19 18 12 07	NW 860722	REG. BC166	14.6 N/D	7.40	149	42	5		0.50	0.73		335	250	10	<1			792	544	274	0.59	CITY OF REGINA
W2 19 18 12 12	NW 860722	REG. BC-K3	29.9 N/D	7.30	190	98	59		<0.1	1.50		595	460	10	<1			1414	880	488	1.25	CITY OF REGINA
W2 19 18 12 13	NW 860722	REG. BC-2	32.6 N/D	7.20	200	102	70		<0.1	1.48		614	520	14	<1			1521	920	503	0.31	CITY OF REGINA
W2 19 18 13 02	SE 860722	REG. BC-4	42.7 N/D	7.50	136	65	34		<0.1	0.90		464	278	8	<1			986	608	381	0.02	CITY OF REGINA
W2 19 18 13 02	SE 860000	REG. BC191	43.9 N/D	7.40	205	108	69	6.0	1.70	0.70		438	252	4				1571	956	533	0.44	MILLARD, 1966
W2 19 18 13 05	SE 860722	REG. BC192	32.3 N/D	7.40	203	86	52	7.0	1.6	1.7		580	483	5	<0.02	<0.03	0.28	1530	1420	859	475	0.18 SRC
W2 19 18 24 02	SE 861103	KING	33.5 U.FL.	7.24	203	86	52	7.0	1.6	1.7		543	689	21	<0.02	<0.03	0.28	1790	1688	1070	445	0.49 SRC
W2 19 18 36 04	SE 861106	JOHNSON	34.7 U.FL.	7.26	296	80	47	8.8	1.10	1.90		543	689	21	<0.02	<0.03	0.28	1790	1688	1070	445	0.49 SRC

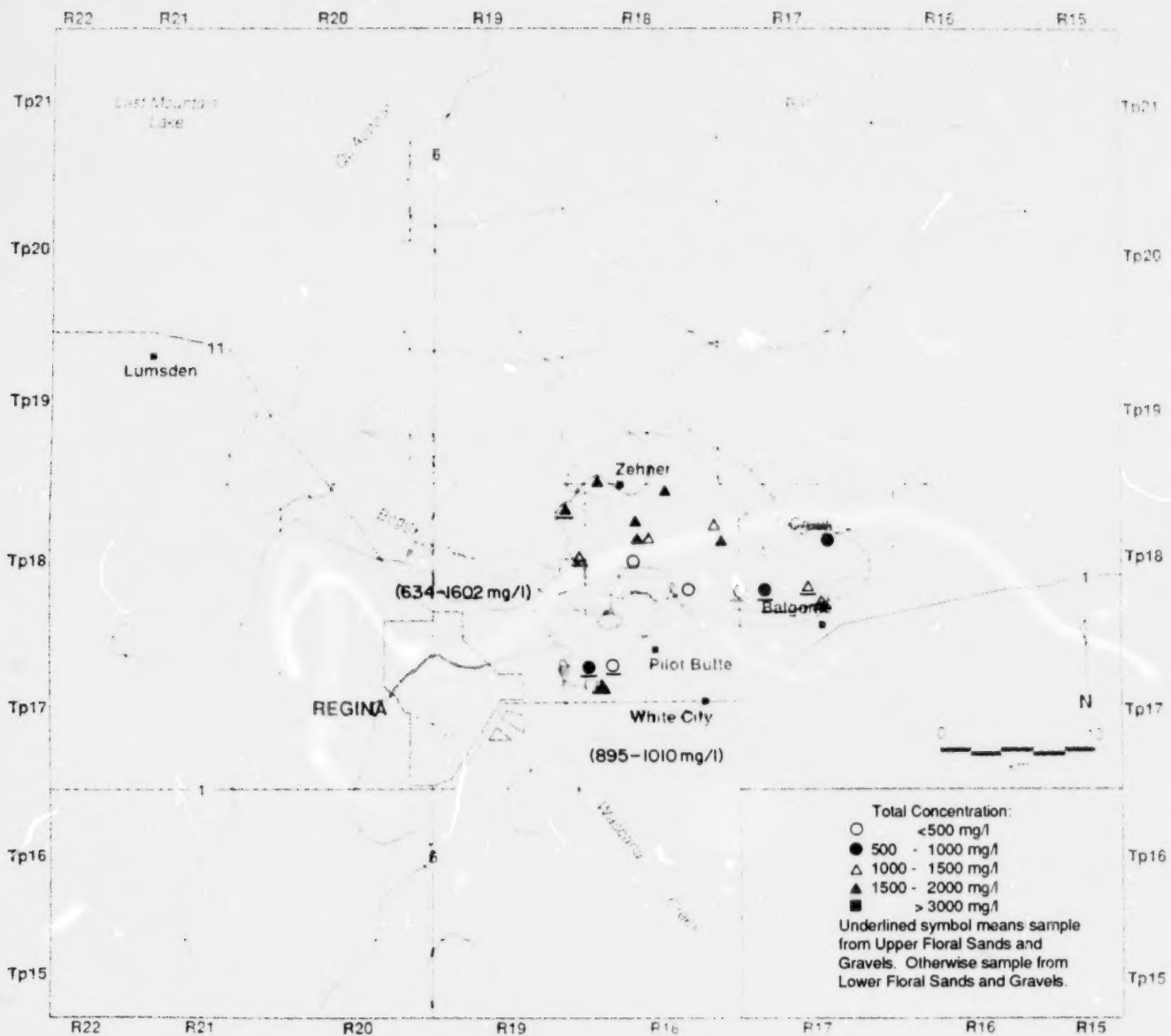


Figure 6.3-1 Distribution of total concentration in Zehner Aquifer System, based on selected groundwater quality data

Water quality data for the shallow gravel pit wells GPW1 to GPW5 are included in Table 6.3-1, although these wells may in fact be completed in the Condie Aquifer. Apart from these, the best quality of water occurs in the south of Township 18, Range 18. This good water has very likely entered the aquifer system by infiltration from Boggy Creek. In this area, the valley of Boggy Creek is eroded into the top of the Upper Floral Formation and recharge by infiltration from the creek has been reported by Wynne-Roberts (1911), and Mollard Assoc. (1975). Occasional flooding of the gravel pits in and near the creek bed has also been reported by the operators. These pits would drain by infiltration to the aquifer system.

The water qualities for the production wells in the Boggy Creek and Mallory Springs well fields are very similar to those found to the north and east within the aquifer system. For Boggy Creek well field the water qualities vary considerably from one well to another without any obvious pattern as to depth or location. Repeat analyses (see Appendix D) show essentially constant water quality for the production wells.

In the area of good quality water associated with Boggy Creek two of the sampled wells show low but significant levels of nitrates (W2-18-18-12-16-SE and W2-18-18-20-01-SW). It can not be determined whether the low level nitrate contamination of these wells is related to point-source or diffuse source of contamination. However, these nitrate levels are of some concern because this part of the aquifer could be readily contaminated.

6.4 Groundwater Withdrawals and Water Level Changes

6.4.1 Boggy Creek Well Field

The production wells of Boggy Creek well field have been producing groundwater at a more or less steady rate since 1911 (see Appendix C). The average yearly withdrawal has been 3700 dam³/year, over the period 1919 to 1987.

The static water levels that have been recorded for the wells over the years give evidence of considerable fluctuation of the water levels, depending on whether nearby wells were pumping. However, the data as listed in Appendix B, give no indication of long-term decline of the water levels. The strongest evidence for a lack of such a decline is in the observation that production wells BC-2, BC-4 and BC-192 are repeatedly recorded as flowing during the winter months when the rate of withdrawal is lowest. These wells are located near the location of the original flowing springs around which the well field was developed. The data thus show that though water levels may drop considerably during heavy pumping, they recover within a few months when pumping slows down.

The degree of interference between the production wells has not been carefully documented, but there obviously are significant interference affects, judging by the variations of static water levels over the years. Monitoring of the water levels in a few observation wells during 1987 also showed the affects of pumping quite clearly (D1-86: W2-18-18-07-02-SW, D4-86: W2-18-18-07-07-NW, and D8: W2-10-18-12-07-NW, see Appendix B). Each of these three observation wells showed a lowered water level in August as compared to the water level recorded in

November, with the lowering equal to 5.7 m, 8.7 m and 2.3 m for D1, D4 and D8 respectively.

It should be noted that the Lower Floral aquifer zones of the Zehner System are increasingly being used as water supply source by farmers and acreages.

6.4.2 Mallory Springs Well Field

The first recorded withdrawals for Mallory Springs well field were in 1930 (data from original hand-written records held by Regina Archives Board). Since then the well field has been pumped at variable rates, averaging 570 dam³/year from 1930 to 1987, with a maximum recorded withdrawal of 1292 dam³ for 1937 (see Appendix C).

The static water level data given in Appendix B show that this well field performs very like the Boggy Creek well field. The recorded static water levels are in the range of 580.2 to 585.5 m. The variation can be attributed to the preceding pumping history. There is no evidence for a long-term decline of the water levels, as shown most clearly by the fact that the wells recover to flowing conditions whenever pumping ceases for a time.

6.4.3 R.M. of Edenwold Production Well No. PW1-85

In March of 1985, a production well, PW1-85, was installed for the Rural Municipality of Edenwold at W2-18-17-29-13-NW, above 3.2 km (2 miles) east of the Mallory Springs wells (Beckie Assoc., 1985). This well was not yet put into production by November 1987. However, during 1987 the water levels in a nearby observation well (OBS E85-3 about

600 m south of the production well) were measured as part of the "instantaneous piezometric surface" program. These data show that the water levels on August 12 were 10.3 m lower than on April 14. This drop of water level is coincident with pumping from Mallory Springs from May to August of 1987.

The large drop of water levels in OBS E85-3 suggests the likelihood of strong interference between the Mallory Springs wells and the Edenwold well. Interference to this degree over a distance of 3 km is unusual, but has been observed elsewhere for wells completed in a narrow strip or channel aquifer (e.g. van der Kamp, 1986). The characteristic "signature" of such aquifers is an increase of drawdown with time during the later stages of a pumping test, with drawdown increasing as the square root of time (slope of 1/2 on a log-log plot). Precisely such behaviour has been observed for both Mallory Springs well P1 (J.D. Mollard Assoc., 1967) and for Edenwold well PW1-85 (Beckie Assoc., 1985). It is quite certain therefore that both wells draw water from the same highly permeable channel aquifer and that strong interference between them is to be expected.

6.5 Hydraulic Properties

A number of pumping tests with observation wells have been carried out within the Zehner Aquifer System. The transmissivities reported for these tests are listed in Table 6.5-1.

In the Boggy Creek well field area the transmissivities range from 3.5 to $7.0 \times 10^{-3} \text{ m}^2/\text{sec}$ (300 to 600 m^2/day). These are relatively low values as compared to the Mallory Springs area where the two values that

TABLE 6.5-1 ZEHNER AQUIFER SYSTEM: TRANSMISSIVITIES FROM PUMP TESTS

AREA	LOCATION OF DATA	WELL NO	SOURCE	TRANSMISSIVITY (M2/SEC)
BOGGY CREEK WELLS	W2-18-18-07-07-NW	BCW7	BECKIE 86	7.0E-3
BOGGY CREEK WELLS	W2-18-18-07-NE	BC6A	MLM 82	4.3E-3
BOGGY CREEK WELLS	W2-18-18-07-NE	P60	LISSEY 62	4.4E-3
BOGGY CREEK WELLS	W2-19-18-12-NE	2A-H61	LISSEY 62	3.5E-3
BOGGY CREEK WELLS	W2-19-18-12-NW	TH1-H61	LISSEY 62	4.7E-3
MALLORY SPRINGS	W2-18-17-29-13-NW	PW1-85	BECKIE 85	3.7E-2
MALLORY SPRINGS	W2-19-17-25-NW	P1-H67	MOLLARD 67B	1.6E-2
BALGONIE AREA	W2-17-18-04-NE	WELL #2	SASK ENV. 70	2.4E-3
BALGONIE AREA	W2-17-18-07-NE	PW1-75	MOLLARD 75	4.8E-3
BALGONIE AREA	W2-18-17-35-04-NW	#2 TRIAL	BECKIE 77	2.4E-4
BALGONIE AREA	W2-18-18-10-16-NE	#3 TRIAL	BECKIE 77	7.8E-4

have been reported are $1.6 \times 10^{-2} \text{ m}^2/\text{sec.}$ and $3.7 \times 10^{-2} \text{ m}^2/\text{sec.}$ It should be born in mind that several of these pumping tests show clear evidence of channel-aquifer type behaviour, particularly in the Mallory Springs area.

Production wells drawing water from channel aquifers are subject to much greater drawdowns than wells completed in extensive plane aquifers. The drawdown "cone" in such channel aquifers will also tend to extend out much further. Drawdowns of 10 metres or more at distances of several kilometers are to be expected. Such drawdowns have been measured in the Mallory Springs area (see section 6.3) and probably also occur in the Boggy Creek well field area. In fact interference between the two well fields, a distance of about 5 km apart, cannot be discounted.

6.6 Groundwater Regime

The overall groundwater regime of the Zehner Aquifer System can be described as comprising relatively strong recharge by infiltration from the ground surface or from Boggy Creek, and rapid lateral drainage, mostly through the Lower Floral aquifer zones, to the springs and wells of the Boggy Creek and Mallory Springs well fields. The result is a high yield of relatively good quality water.

The continuity and high permeability of the lower aquifer zones is attested to by the low water levels encountered in the north and east of the aquifer system, the flatness of the piezometric surface, and the high long-term yield of the wells and springs.

Recharge from the overlying Condie Aquifer in the Boggy Creek well field area is probably minor. In fact, it appears that the Zehner Aquifer System may be contributing recharge from below to the Condie Aquifer. This at least is the case in the area just north-west of Pilot Butte where the hydraulic head in the Condie is lower by about 4 m than in the underlying Upper Floral sands (SWC Regina 2 and SWC Regina 3, W7-18-18-04-05-NW). Within the Boggy Creek well field the flow may be downward from the Condie Aquifer. However, the stratigraphic identity and continuity of the shallowest aquifer zones are not firmly established and it is not clear whether they should be considered as part of the Condie Aquifer.

The amount of recharge entering the aquifer system via infiltration from Boggy Creek in the south-east of Range 18, Township 18 is difficult to estimate. Such recharge certainly occurs, but the amount depends on the infiltration capacity of the creek bed and on the length of time that the creek is actually flowing. The occurrence of good quality groundwater in the area is presumably associated with this recharge and it is possible that a "plume" of this good quality water extends as far as the well fields.

The production wells in the Boggy Creek and Mallory Springs well fields should be considered as drawing almost entirely on "run-of-the-stream" water. This water flows to the wells and springs via highly permeable channel-type aquifers which, however, have relatively little storage capacity in the area of the well fields. The rapid recovery of some of the wells to flowing conditions provides strong evidence for this interpretation.

Data as to possible decline of water levels in the north and east parts of the aquifer system are lacking. However, lack of such a decline at the well fields means that declines at further distances are very unlikely. Probably the recharge and discharge of the system are much the same now as they always were, but the production wells now intercept nearly all the discharge flow which used to go to springs and seeps.

During periods of heavy pumping the water levels in the well fields are subject to large drawdown and these drawdown propagate rapidly to distances of several kilometres and perhaps as far as 10 kilometres or more.

6.7 Water Balance

As argued in the fore-going section, the recharge and discharge plus withdrawals of the Zehner Aquifer System have probably been little changed by pumping from the well fields. The production wells essentially intercept flow that would otherwise have issued at nearby springs and seeps. The major water balance components of the aquifer system therefore do not include any important long-term changes of water held in storage. The water balance averaged over the period 1978 to 1987 can be summarized as follows:

1.	Recharge	
	(a) From Boggy Creek	1000 to 2000 dam ³ /year
	(b) Infiltration from ground surface	4000 to 6000 dam ³ /year
	(c) From Condie Aquifer	0 to 500 dam ³ /year
	Totals	5000 to 8500 dam ³ /year

2.	Discharge plus Withdrawals	
(a)	From Boggy Creek Wells	4400 dam ³ /year
(b)	From Mallory Springs Wells	500 dam ³ /year
(c)	Town of Balgonie	210 dam ³ /year
(d)	To Regina Aquifer through hydraulic barrier	1000 to 1500 dam ³ /year
(e)	To Condie Aquifer	0 to 500 dam ³ /year
(f)	To flowing wells and springs	300 to 600 dam ³ /year
	Totals	6400 to 7700 dam ³ /year
3.	Change in Storage	-1000 to +1000 dam ³ /year

With regard to recharge, the total volume of water entering the aquifer system from Boggy Creek is probably relatively small, considering the limited infiltration area and short duration of inflow. Most of the recharge is probably depression-focussed, and is spread over the entire area of the aquifer system. The estimated rate of 4000 to 6000 dam³/year is equivalent to 25 to 40 millimetres per year over the 150 km² area of the system. This rate of recharge is not unreasonably large, but implies that glacial tills overlying the aquifer have fracture permeability similar to the value of 10^{-8} m/sec found by Keller et al. (1986) for till of the Upper Floral Formation near Saskatoon.

Recharge from the Condie Aquifer is reckoned to be relatively minor, and probably about balanced by discharge to the Condie Aquifer.

Withdrawals from the Boggy Creek and Mallory Springs well fields have averaged 4400 and 500 dam³/year respectively over the past 10 years. This combined rate is slightly higher than the average rate of 4300 dam³/year since 1929. The aquifer system can certainly sustain the recent yield of 4900 dam³/year and in fact some water is lost most years from flowing wells in the well fields. Flow to the Regina Aquifer through the hydraulic barrier in the east half of Range 19, Township 18

was estimated in Chapter 5 to be about 1000 to 1500 dam³/year, based on the observed hydraulic gradient in the Regina Aquifer.

Since the well fields exhibit no long-term decline of static water levels, the overall change of water held in storage in the aquifer system must be small. The active storage capacity of the system lies mostly within the Upper Floral sands which are dry or under water table conditions over much of the area. This active storage can be estimated to be in the range of 5000 to 10,000 dam³ per metre of water-level change.

The town of Balgonie pumps about 210 dam³/year from its well in W2-17-18-07-NE (Stanley Assoc., 1988).

The most important aspect of the water balance is that the available yield of the Zehner Aquifer System is already almost fully utilized by the existing well fields. The recharge rate is already at a near-maximum since the downward gradients from the ground surface are near unity. Thus production wells positioned elsewhere in the system would do little to increase the total yield. The flow to the Regina Aquifer could be intercepted. This would merely decrease the available yield from the Regina Aquifer by the same amount, though there might be water quality advantages since this water would not be subject to possible contamination by water from the Condie Aquifer which overlies the Regina Aquifer.

The yield of the system could be enhanced by increasing the infiltration from Boggy Creek. This possibility will further explored in Chapter 9.

A minor increase of yield could be obtained by re-scheduling the

pumping pattern in such a way as to prevent water loss from flowing wells. Presumably pumping from the Regina aquifer could be reduced accordingly and there would be a slight net gain in the total yield available from the Regina Aquifer during high-demand periods.

6.8 Susceptibility to Contamination

The Zehner Aquifer System is well protected from contamination over almost its entire area by layers of glacial till. These tills are probably fractured and have relatively high permeability, but they will still serve as an effective barrier, stopping many contaminants by adsorption and slowing more mobile contaminants so that they would take decades to reach the aquifer zones.

The one place where the aquifer system is highly susceptible to contamination is along the bed of Boggy Creek in Range 18 where it is eroded into the top of the Upper Floral sands along much of its course and where also gravel pits provide direct connections between the creek and the aquifer. Contaminants carried by the creek can be readily transported into the aquifer system via these exposed aquifer zones. The upper reaches of the Boggy Creek watershed are presently used mostly for agriculture, and it is likely that no serious contamination has occurred to date, though this would bear checking out. In the future this part of the Boggy Creek watershed may require special water-supply protection measures, particularly if recharge enhancement using Boggy Creek water is to be considered.

7 GROUNDWATER RESOURCES OF THE "NORTHERN AQUIFER SYSTEM"

7.1 Definition and Extent

The "Northern Aquifer System" comprises the poorly defined aquifer zones of the Upper and Lower Floral Formations in Ranges 17 through 20, Townships 21, 20 and the north half of Township 19. Its approximate extent is shown in Figure 7.1-1. The name "Northern Aquifer System" is purposely put in quotation marks here to emphasize that the extent and continuity of the system is uncertain.

Major groundwater withdrawals from the system occur only at Mound Springs well field (W2-19-19-31). For the rest, water is withdrawn only by widely scattered farm wells. Hence little data is available except in the immediate vicinity of Mound Springs well field.

7.2 Piezometric Surface

The available water-level data for recent years are shown on Maps 9 and 11 (Maathuis and van der Kamp, 1988a). The water-level data are very limited and provide little indication as to flow directions. It is clear that in the area just east and north of the well field a number of farm wells have static water levels roughly equal to those presently recorded for the well field. These farm wells clearly draw from the same aquifer zone.

7.3 Water Quality

Selected water quality data for the "Northern Aquifer System" are given in Table 7.3-1 and are shown in Figure 7.3-1. These data are also shown on Map No. 12 (Maathuis and van der Kamp, 1988a). No water

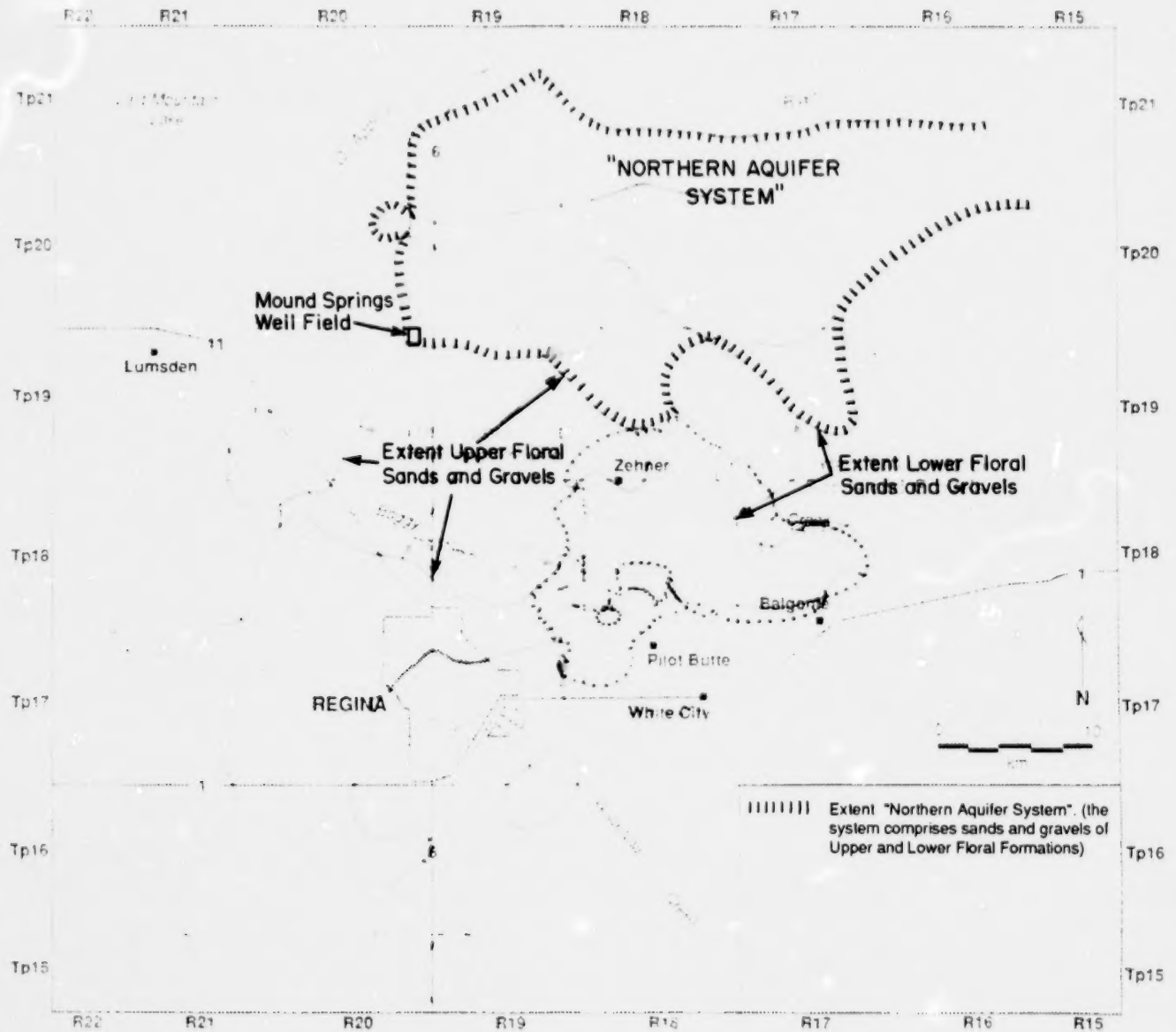


Figure 7.1-1 Extent of the "Northern Aquifer System"

TABLE 7.3-1 SELECTED WATER QUALITY DATA FOR "NORTHERN AQUIFER SYSTEM"

LAND LOCATION XX XX XX XX-XX-XX XX YYYMMDD	DATE	WELL NAME	WELL DEPTH M	PH	CA MG/L	MG/L	NA MG/L	K	FE MG/L	MN MG/L	CO3 MG/L	HCO3 MG/L	S04 MG/L	CL MG/L	NO3 MG/L	PM4 MG/L	F MG/L	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	ERROR BALANCE %	REFERENCE
M2-18-19-31-14 SE 750211 SCHMIDT			64.0 L.F.L.	7.06	211	130	76	10.0	0.74	1.80		742	583	17	25.7	<0.01	0.38	1740	1798	1060	608	0.86 SRC	
M2 19 19 31 12 SW 860700 REG. M2			26.3 L.F.L.	7.20	120	79	52		0.90	1.16		489	300	10	<1				1052	624	401	0.70 AFSL., 1981	
M2 19 19 31 12 SW 860722 REG. M3A			33.7 L.F.L.	7.50	117	66	42		<0.1	0.98		495	242	10	<1				973	564	393	1.28 CITY OF REGINA	
M2 19 19 31 12 SW 860722 REG. M4			28.7 L.F.L.	7.50	155	86	59		<0.1	1.44		565	390	14	<1				1270	740	446	1.14 CITY OF REGINA	
M2 19 19 31 13 NW 860722 REG. 14A			45.1 L.F.L.	7.50	181	108	70		0.60	0.66		672	480	14	<1				1526	896	551	1.04 CITY OF REGINA	
M2 19 19 31 13 NW 800700 REG. M1			42.1 L.F.L.	7.10	166	109	66		2.50	0.80		608	488	4	5.0				1449	864	498	0.49 AFSL., 1981	
M2-19-19-31-14 NE 860722 REG. P2			49.1 L.F.L.	7.30	174	113	71		0.70	0.75		707	450	12	<1				1528	900	558	0.54 CITY OF REGINA	
M2 19 20 05 04 NE 750211 NEHLS			49.4 L.F.L.	7.20	162	89	61		8.0	6.00	2.48	598	410	7	<0.1	<0.01	0.45	1430	1344	770	490	0.80 SRC	
M2 19 20 05 08 SE 750211 DAVIES			65.2 L.F.L.	7.22	198	105	70		20.0	4.10	10.30	764	466	13	0.2	<0.01	0.35	1690	1651	927	627	1.20 SRC	
M2 19 20 06 02 SW 750211 WAGNER			32.3 L.F.L.	7.08	187	105	73		7.0	14.10	0.86	682	488	7	0.3	0.03	0.40	1550	1565	899	559	0.56 SRC	
M2 19 20 06 09 SE 750211 RITTER			54.9 L.F.L.	7.06	199	99	70		7.0	7.85	0.86	711	475	<1	0.1	0.04	0.38	1540	1570	903	583	0.62 SRC	
M2 19 20 19 12 SW 750212 WAGNER			56.7 L.F.L.	7.12	182	103	43		7.0	0.02	<0.01	621	446	18	3.5	<0.01	0.76	1450	1424	876	509	1.17 SRC	
M2 19 20 31 16 NE 750211 MILLER			68.6 L.F.L.	7.10	248	166	56		8.0	4.20	5.90	755	789	11	2.3	<0.01	0.49	2050	2046	1300	619	0.87 SRC	
M2 19 20 36 14 SW 750211 INNES			80.5 L.F.L.	7.15	362	224	151		8.0	11.80	1.11	888	1360	14	4.0	0.07	0.43	2900	3024	1822	728	0.10 SRC	

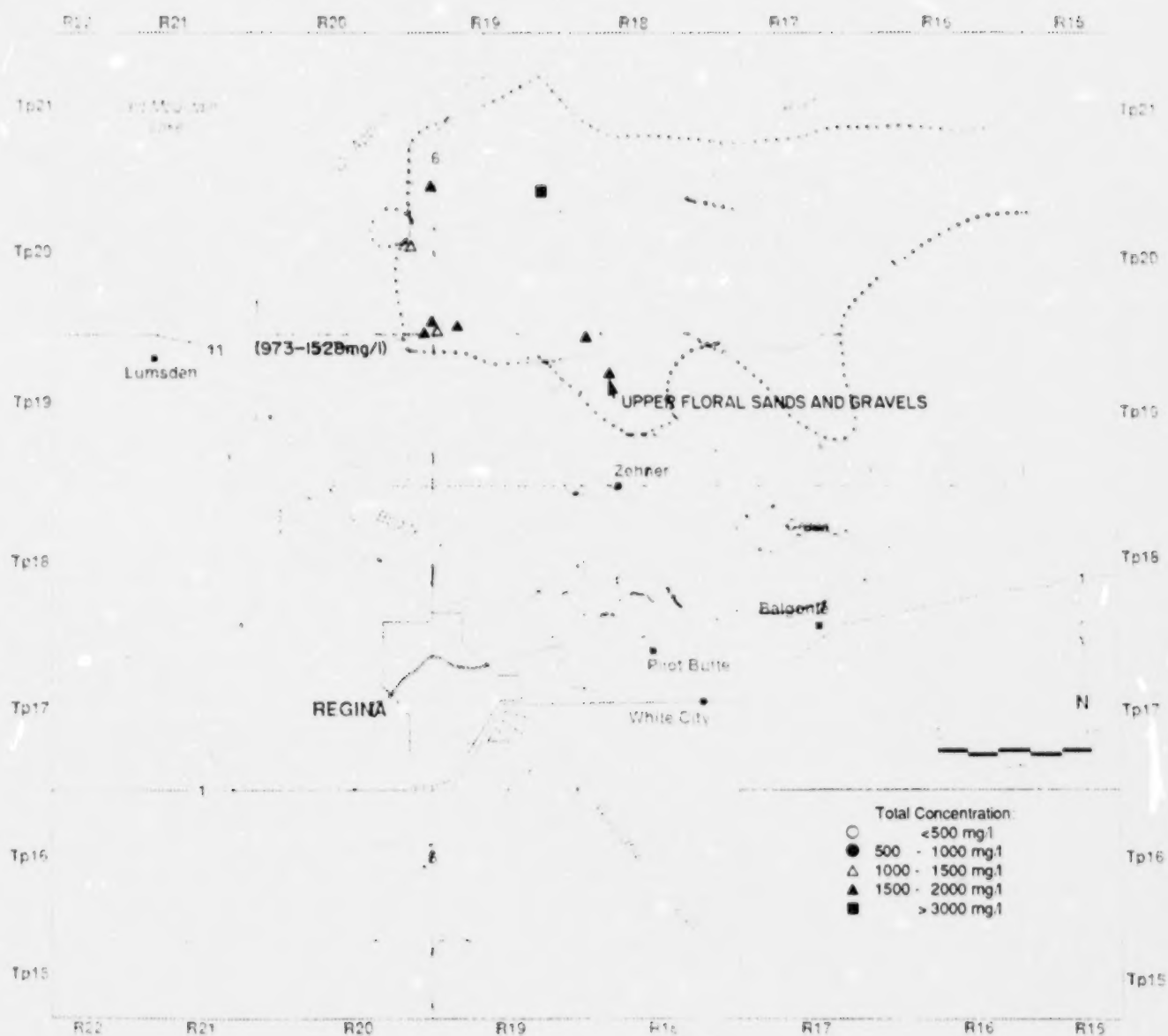


Figure 7.3-1 Distribution of total concentration in "Northern Aquifer System", based on selected groundwater quality data

quality data are available for the Upper Florid aquifer zones of the aquifer system. Repeat analyses for the Mound Springs wells are given in Appendix D, Table D-1. These show no significant changes of water quality over the past 20 years.

The water analyses show typical water for intertill aquifers, with sum of ions ranging from 973 to 3042 mg/L. Within the well-field area the water is of a calcium/magnesium-bicarbonate/sulfate type with sum of ions from 973 to 1528 mg/L. The iron concentrations for the production wells varies considerably for repeat samples, e.g. from 0.70 to 3.50 mg/L for well P2. This variation probably reflects differences in sampling and sample preservation techniques.

7.4 Withdrawals and Water-Level Changes

The earliest recorded withdrawals for the Mound Springs well field are for 1935 (see Appendix C). Between 1935 and the present, the rate of withdrawal has averaged about 1600 dam³/year, but records are very limited up to 1969. During the ten-year period 1970 to 1987 the withdrawal rate has averaged 1900 dam³/year.

The first test wells were drilled in the well field area in 1929 (Hill et al., 1930). At that time the springs were flowing at a rate of about 630 dam³/year (380,000 gallons per day). The first test wells encountered flowing conditions with static water levels about 3 to 6 metres above ground level, corresponding to a hydraulic head of about 601 metres above sea level. Since that time the static water levels in the well field appear to have declined to between 589 and 595 metres in recent years (see Appendix B). Inspection of the site suggests that the

springs have not flowed for many years. It appears that the water levels declined fairly rapidly by about 5 to 10 metres after withdrawals started, but the levels appear to have been more or less stable for many years.

7.5 Hydraulic Properties

The hydraulic properties of the "Northern Aquifer System" are probably similar to those of other intertill aquifer systems in the region.

The only data for transmissivity of the Lower Floral sands and gravels comes from two pumping tests conducted at Mound Springs well field. Lissey (1962) reported a transmissivity of $1.3 \times 10^{-3} \text{ m}^2/\text{sec}$ from a test on well 9G. Mollard (1967A) reported value of $2.2 \times 10^{-3} \text{ m}^2/\text{sec}$ for well PW2-H1967. These two values give an average of $1.8 \times 10^{-3} \text{ m}^2/\text{sec}$ ($160 \text{ m}^2/\text{day}$).

7.6 Groundwater Regime

The limited available data provide little information as to the groundwater regime of the "Northern Aquifer System". Recharge to the aquifer system presumably occurs largely via depressions in the uplands and discharge is concentrated in the Mound Springs well field area and presumably along the south slope of the Qu'Appelle valley, particularly in the numerous gullies leading into the valley.

The occurrence of vigorously flowing springs in the Mound Springs well field area must be due to an aquifer boundary, as shown on Map Nos. 5 and 11 (Maathuis and van der Kamp, 1988a). The topography of the area

is not such as to lead to spring formation. The ground surface drops away fairly rapidly to the west of the springs.

It should be noted that springs in the Flying Creek Watershed, about 6 kilometers to the west, were reported to be flowing at a combined rate of about $600 \text{ dam}^3/\text{year}$ (350,000 gallons per day) in 1930 (Hill et al., 1930, Cooper and Dixon Springs). The water quality was reported as similar to Mound Springs. These springs are still flowing presently, but the rate of flow has not been measured. The aquifer zone from which these springs presumably discharge appears to be part of the Regina Aquifer (Maathuis and van der Kamp, 1988a: Map No. 9). A hydraulic connection to the "Northern Aquifer System" has not been found in test-hole data, but the rate of flow of the springs strongly suggests a connection with a larger recharge area which would have to be the "Northern Aquifer System".

The static water level at Mound Springs well field appears to have stabilized at about 5 to 10 metres below the original static level. The original spring flow, reported as about $630 \text{ dam}^3/\text{year}$ in 1930, was considerably less than the average rate of withdrawals since then, of 1600 dam^3 per year. Presumably the lowered static levels have induced additional recharge to the aquifer zones in the area east of the well field and have also led to a decrease of flow from other springs and seeps in the area. The net result has been a new dynamic balance between recharge and discharge.

The groundwater divide between the Zehner Aquifer System and the "Northern Aquifer System" has been assumed to lie within the Upper Floral sands along a line dividing the north and south halves of

Township 19. It is possible that the divide is further north, depending on whether drainage of groundwater north to the Qu'Appelle Valley is as strong as drainage south to the Boggy Creek well field area.

7.7 Water Balance

The limited data for the "Northern Aquifer System" allow only speculative statements as to its water balance. The total rate of recharge to the system may be assumed to be in dynamic balance with the withdrawals from Mound Springs well field, and with discharge, mainly to the Qu'Appelle Valley.

The total rate of discharge to the Qu'Appelle Valley is not known, but is likely to be high. It is probably in the range of 5000 to 10,000 dam³ per year, assuming that Upper and Lower Floral aquifer zones are indeed continuous to the Qu'Appelle Valley as shown on Maps 3 and 5 (Maathuis and van der Kamp, 1988a).

If withdrawals from Mound Springs well field were stopped, the static water levels would rise and the springs in the well field area would flow again as they used to. Such spring flow, and the associated seeps, would affect land use downstream from the well field.

7.8 Susceptibility to Contamination

The "Northern Aquifer System" is well protected from contamination by the overlying tills which are continuous over the entire area of the system. This geological protection, in conjunction with the low-intensity agricultural land use in the recharge area, means that the groundwater supply from the system is very secure as far as possible

contamination is concerned. This water quality consideration may have an important bearing on management decisions as to future groundwater withdrawals from the system. The other main aquifers supplying water for Regina are all to various degrees, more susceptible to contamination.

8 GROUNDWATER RESOURCES OF MINOR AQUIFERS

8.1 Small Glacial Drift Aquifer Zones

The four major aquifers or aquifer systems described in the foregoing chapters are the source for most of the groundwater used in the Regina area including all the larger supplies. However, there are many wells completed in smaller aquifer zones within the glacial drift. The water-level and water quality data given in Appendices B and D include many wells with unidentified aquifer zones. For these wells the stratigraphy could not be determined due to lack of a clear relationship with aquifers or test holes for which stratigraphy is firmly established. These wells are located outside the areas of the main aquifers. They provide water for many small-consumption uses.

The extent and possible yield of some of these non-determined aquifer zones may be considerable. As more data becomes available, some of them may prove to be hydraulically connected to the main aquifers.

8.2 The Richardson Aquifer

The Richardson Aquifer is a small but clearly identified aquifer zone of the Upper Floral Formation. It lies mostly within Range 19, the north-east corners of Township 16 and the south-east corner of Township 17 (see Figure 8.2-1). The extent of this aquifer is somewhat in doubt. J.D. Mollard and Assoc. (1968) found it to consist mostly of a highly permeable channel aquifer, but did not follow out its full extent.

The Richardson Aquifer is characterized by slightly flowing conditions and by rather poor water quality with sum of ions in the 2200 mg/L range (see Appendix D). The water is of the sodium-

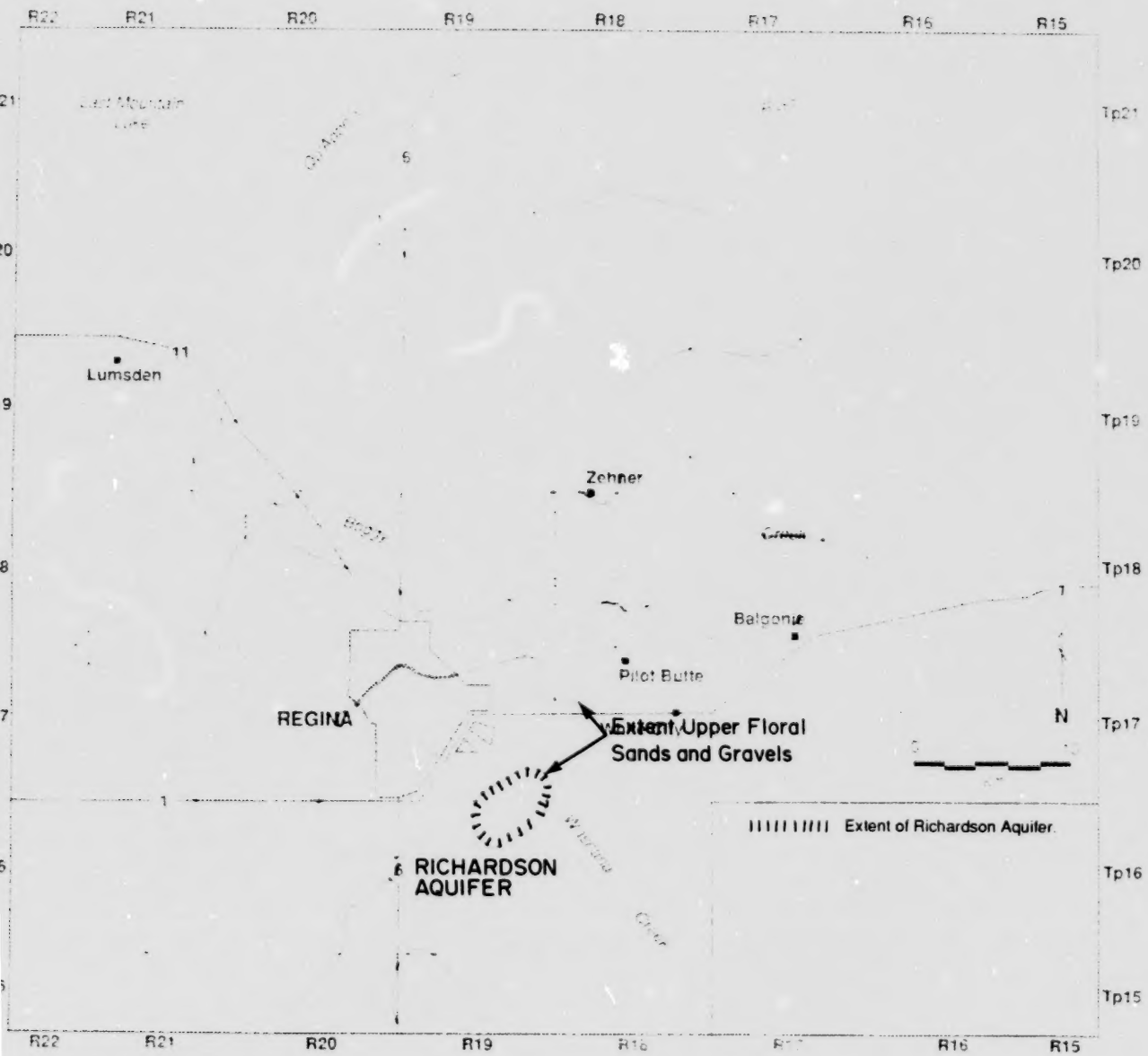


Figure 8.2-1 Extent of the Richardson Aquifer

bicarbonate sulfate type with relatively high iron and chloride. This water quality is similar to that found in the scattered occurrences of the Empress Group (see Section 8.3), and to the water quality encountered in the south-west part of the Regina Aquifer (Ranges 20 and 21, Townships 16 and north part of Township 17). It appears that this water type is associated with aquifer zones that are contiguous to the bedrock shales.

At about 575 metres (see Appendix B), the hydraulic head in the Richardson Aquifer is well above that of the Regina Aquifer to the north and west. This and the fact that static levels are slightly above ground level suggests that the Richardson Aquifer has some connection with higher-lying aquifer zones to the north-east. The relatively poor quality of the water and the lack of large springs however, indicate that the connection is poor.

Due to the limited extent the total available yield from this aquifer is probably small, even though the transmissivity where the aquifer is thickest is quite high, $5.6 \times 10^{-2} \text{ m}^2/\text{sec}$ (J.D. Mollard and Assoc., 1968, W2-19-16-35-04-SW).

8.3 Aquifer Zones of the Empress Group

Sands and gravels of the Empress Group do not appear to form aquifers of any large extent in the Regina area, except in the north-west near the Qu'Appelle Valley (Range 20, Township 20).

Five water quality analyses are available for the Empress Group (see Appendix D). The sum of ions ranges from 960 to 2910 mg/L and the

water is of a sodium/calcium-sulfate/bicarbonate type with relatively high levels of chloride and iron.

8.4 Bedrock Aquifers

The Ardkenneth member of the Bearpaw Formation is present in parts of the Regina area (see Maathuis and van der Kamp, 1988a: cross-sections) but no wells are known to be completed in it. Water from the Ardkenneth would probably be high in sodium and chloride and perhaps unsuitable for drinking purposes.

The Mannville Formation occurs throughout the area at depths of about 700 to 900 metres. Lissey (1962) reports that the Mannville has moderately saline water (6,000 mg/L) at the location of the Kalium Potash Mine (W2-24-17-11), about 40 km west of Regina. Within the Regina area the Mannville has not been used for water supply. It has been used for waste and brine disposal by fluid injection at several locations. Deeper bedrock formations have also been used for fluid waste disposals. These disposal wells are listed below (data provided by Saskatchewan Energy and Mines, Petroleum and Natural Gas Division):

<u>Location</u>	<u>Name</u>	<u>Formation</u>	<u>Status</u>
W2-18-16-22-01	Petrocan	Mannville	active
W2-19-18-05-01	Co-op	Mannville	active
W2-20-17-29-07	Procor	Mannville	suspended
W2-20-17-29-7	Procor	?	suspended
W2-20-16-27-15	SPC	Devonian	suspended

9 GROUNDWATER MANAGEMENT AND PROTECTION

9.1 Well Field Expansions

9.1.1 Condie Aquifer East

A considerable volume of good-quality water could be withdrawn from the eastern half of the Condie Aquifer each year. The potential yield in excess of current withdrawals is estimated to be in the range of 1000 to 1500 dam³/year. At present the eastern part of the aquifer is being pumped by the town of Pilot Butte and White City and by scattered small users, the total rate of withdrawal being about 400 or 500 dam³/year.

It is interesting to note that the so-called "Eastern Scheme" proposed by Wynne-Roberts in 1912 essentially would have intercepted the flow of springs discharging from the Condie Aquifer. The scheme was not carried through, apparently because the springs were considered unreliable due to their shallow source (Hill et al., 1930).

Water demand in the Pilot Butte - White City area is growing rapidly (Stanley Associates, 1988). The Condie Aquifer in this area is highly susceptible to contamination. For these two reasons withdrawals of water from the eastern part of the Condie Aquifer should probably be limited to local users.

9.1.2 Condie Aquifer Central and West

Recharge to the central and western parts of the Condie Aquifer (Ranges 19, 20 and 21) is already virtually entirely being utilized for withdrawals and for recharge to the Regina Aquifer. There is therefore no scope for additional withdrawals.

The most important factor with regard to management of the central

part of the Condie Aquifer is the occurrence or potential occurrence of contamination. The rising chloride levels in city well R2 are indicative of contamination and production from this well may soon have to cease on this account. The concern over contaminants moving into the Regina Aquifer will remain.

One way of improving and safeguarding water quality would be to intercept as much as possible of the flow of good quality water entering the central part of the Condie Aquifer by means of a few well-placed shallow production wells along the eastern edge of Range 19. Such wells could yield up to 1500 dam³ per year of good quality water, close to existing water mains. The purpose of such a pumping scheme would be to slow the movement of water and contaminants in the Condie Aquifer further west by reducing the horizontal hydraulic gradient in the Condie Aquifer and the vertical head difference with the Regina Aquifer. The available yield of the Regina Aquifer would eventually be reduced by a roughly equal volume as that pumped from the Condie Aquifer. However, the water would now be withdrawn before it could be contaminated in the Condie Aquifer further west, or before it would be mixed with poorer quality water in the Regina Aquifer. In addition, the potential movement of contaminants into the Regina Aquifer would be slowed, thereby improving the prospects for the long-term availability of this aquifer.

This proposed pumping scheme was in fact more or less in place for many years while the "10-inch line" was supplying water to the City from its 15-inch extension in Sections 1 and 2 of Township 18, Range 19. The average rate of supply from the 10-inch line between 1904 and 1959 was

670 dam³/year, without any effects on water levels elsewhere being noticed. It is very likely, though not definitely proven, that the 10-inch line was intercepting flow which would otherwise have continued on westward through the Condie Aquifer. Further evaluation of this scheme would require confirmation as to the continuity of the Condie Aquifer in the area between the Boggy Creek well field and the Regional Correctional Centre.

9.1.3 Regina Aquifer

Most of the available yield from the Regina Aquifer is already being utilized. The one exception is in the north-west of the aquifer where relatively good-quality water is presently discharging to Boggy Creek at a rate of about 500 to 1000 dam³ per year. This discharge could be intercepted by one or two judiciously placed production wells positioned approximately in the north-west of Range 20, Township 18. The present users of the springs would presumably have to be accommodated.

Additional production wells could be put into the Regina Aquifer for the purpose of either meeting peak demands or to take advantage of locally better water quality within the aquifer.

9.1.4 Boggy Creek Well Field

Boggy Creek well field has been operating at more-or-less the maximum available yield for many years, and further expansion of the well field would provide at most a short-term increase of yield. Further drawing-down of the hydraulic head in the Zehner Aquifer System

will not materially increase the rate of recharge, which is now and always has been at near-maximum rate. The total yield of the well field could be improved slightly by scheduling the pumping such that loss of water from flowing wells is reduced.

As proposed in Section 9.1.2, additional production wells could be placed to withdraw water from the Condie Aquifer just west and south of the Boggy Creek well field. Since the Condie Aquifer probably interacts with the Boggy Creek wells, such pumping might slightly reduce the water levels and yields in the Boggy Creek well field.

There is good evidence that there is a relatively strong lateral inflow of water into the Regina Aquifer through approximately W2-19-18-10 (the area of the Genstar Plant). It is likely that this flow passes through or near the Boggy Creek well field by means of some as yet unidentified aquifer zone. If the path of the flow could be located it might be advantageous from a water quality standpoint to intercept it by pumping. Such withdrawals would of course reduce the available yield from the Regina Aquifer by an equal amount.

9.1.5 Mallory Springs Well Field

Withdrawals from the Mallory Springs well field are probably at near the sustainable yield levels, although water is lost in some years because the wells flow. The new Edenwold well 3 kilometres to the east appears to be drawing on the same source of supply and the total available yield may need to be apportioned between them.

9.1.6 The "Northern Aquifer System"

There are probably considerable resources of groundwater available from the "Northern System" near the Qu'Appelle Valley. However, distance probably precludes development of this supply for many years to come. Mound Springs well field appears to be operating at its maximum sustainable yield.

9.2 Recharge Enhancement

Recharge enhancement may be feasible along the course of Boggy Creek in Range 18, Township 18. Water from Boggy Creek recharges the Zehner Aquifer System already, and the rate and total volume of recharge could be enhanced by ponding the water over a larger area and for a longer time. Such ponding would presumably involve building of dams or controlled flooding of the gravel pits in the area.

The average runoff from the Boggy Creek watershed is not all that large. Total annual flow recorded for Boggy Creek near Lumsden has ranged from 50 to 15,600 dam³ over the period 1968 to 1986, averaging about 5,100 dam³. The runoff from the upper watershed in Range 17 and 18 would presumably be considerably smaller. Significant recharge could probably only be carried out in the wettest year.

Such occasional recharge enhancement would be practicable as far as the yield of the Zehner Aquifer System is concerned because the total storage capacity of the Upper Floral aquifer zones near the creek is very large, perhaps as much as 50,000 dam³. The additional water recharged in this way could be withdrawn by means of nearby wells or it could be left to increase the flow of groundwater to the Boggy Creek and

Mallory Springs well fields.

A recharge enhancement project of this nature would require rigorous protection of the watershed from contamination. It would also require a much more detailed evaluation of the hydrological and hydro-geological aspects of such a scheme. One advantage of the scheme would be to reduce flooding problems along the downstream reach of Boggy Creek in the wettest year, provided that sufficient surface storage capacity could be put in place.

With regard to recharge enhancement it should also be noted that recharge enhancement by means of leaking water and sewer pipes has presumably been going on in the Regina urban area for many years. Since there is a strong downward gradient to the Regina Aquifer, much of the water lost from leaking pipes is probably contributing to recharge to the aquifer. This additional recharge may be a significant factor in the levelling-off of the water-level decline of the aquifer. It is ironical to consider that such leakage, normally considered as a loss, may be largely re-cycled in the case of Regina. The downward gradient to the Aquifer may also be helping to keep the water table down, thereby reducing moisture problems in basements.

9.3 Artificial Recharge

The far western part of the Condie Sands and gravels present a promising opportunity for artificial recharge. The Condie sands are almost entirely unsaturated in this area (west half of Range 20, east half of Range 21) and have a very large storage capacity, probably amounting to about 50,000 dam³. The area is not urbanized at present

and industrial activity appears to be limited to some small gravel-pit operations. It lies only a few kilometres north of the pipeline from Buffalo Pound.

During periods of low water demand the excess capacity of Buffalo Pound could be used to pump water for artificial recharge to the top of the Condie Moraine where it would infiltrate via shallow lagoons dug into the top of the Condie sands. This water would remain in storage and could be pumped out more or less at will to meet peak demands. Much of it would in fact go to recharge the underlying Regina Aquifer, which provides additional storage capacity.

A scheme of this nature was first proposed by J.D. Mollard and Associates in 1960. The economic and technical viability of such a scheme of artificial recharge would be worth a more detailed investigation.

9.4 Contamination and Future Groundwater Use

In the coming years the most difficult groundwater management decisions for the Regina area will probably be those dealing with the use of groundwater for public water supplies in the presence of known, suspected or potential contamination. These decisions will involve the costs and benefits of the various groundwater supplies versus the costs and benefits of detecting, reducing and preventing contamination.

There can be no doubt that decisions with regard to groundwater use and contamination should be made within the regional context. Within the major aquifer zones groundwater flow velocities may be as high as 500 metres per year; thus the potential exists for contaminants to move

over distances of kilometers, a regional scale, within a few years. It would be futile to concentrate on a few main contaminant sources while neglecting others that would probably affect the same aquifer system. For the same reason of high aquifer permeability, ground water movement can be influenced or controlled over distances of kilometers by pumping. Thus hydrodynamic control of groundwater movement is also possible on scales of kilometers, (see for instance Section 9.1.2 regarding hydrodynamic control of contaminant movement in the Condie Aquifer).

Within the regional context, more local problems will also have to be addressed, down to the very small scale of individual leaking well casings.

Protection of groundwater recharge areas is already a management concern, as witness the recent debate regarding railway relocation. In the future, protection of sensitive recharge areas may become an urgent necessity. Areas of particular concern in this regard would be the watershed of Boggy Creek in Ranges 17 and 18, and the Condie Moraine in Ranges 20 and 21. In both these areas contamination is probably minor at present, if it has occurred at all. But these two areas are prime candidates for artificial or enhanced recharge - a possibility that would be practically eliminated if serious contamination occurs.

Protection of groundwater quality in the eastern half of the Condie Aquifer cannot be overlooked. Many users, including the town of Pilot Butte and White City depend on the aquifer for a reliable supply of good quality water. But the aquifer is highly susceptible to contamination and may indeed already be contaminated at many points.

Management of groundwater in the Regina area also has environmental

and geotechnical implications. Withdrawal of groundwater has led to drying-up of springs in the Boggy Creek, Mallory Springs and Mound Springs well fields, and to lowered water levels, particularly in the Regina Aquifer. If withdrawals were to be reduced or to cease altogether the groundwater levels would rise and springs that have been dried-up for decades might again begin to flow. If pumping from the Regina Aquifer were stopped, the hydraulic head in the aquifer would rise by several meters within a few years. The water table within the overlying clayey materials would rise in response. The higher water table could lead to various geotechnical and contaminant problems. The possible impacts of these effects should be considered if withdrawal rates are to be changed.

9.5 Alternative Uses

Groundwater in the Regina area is now used mainly for public drinking water. The consumers Co-operative Refinery is the major industrial user of water, but there are many minor industrial and agricultural users (Stanley Assoc. 1988). One alternative use for groundwater where contamination becomes a concern would obviously be to direct the groundwater more to industrial and agricultural use.

An alternative use of groundwater that is likely to be of increasing importance is its use for heating and cooling by means of heat pumps. Certainly the major aquifers of the area can sustain a large heating and cooling load. Even major buildings in the urban area could be heated and cooled economically by means of groundwater. Moreover, such use of groundwater is non-consumptive if the water is re-injected,

in that it would not need to interfere with other uses of the water. The major concern with this use of the water would be that it would increase the possibilities for contamination. In addition of course it would be necessary to be on guard against large changes of water temperature.

Groundwater usage also has an important effect on wetlands and creeks in the Regina area. For instance, Mackay, Beach and Scott (1936, p.11) mention of Boggy Creek that in Ranges 19 and 20 "The creek is fed by springs and except in very dry seasons flows continuously". It certainly does not do so at present, presumably because of the heavy withdrawals from the Boggy Creek well field and the Regina Aquifer, which essentially transfer the flow to Wascana Creek through the Sewage Treatment Plant. Changes of groundwater pumping would have important effects on the ecology and land-use of wetlands and creek beds.

9.6 Data Requirements

Sound management of the groundwater resources in the Regina area will require more and better data on hydrogeology, water levels, pumping rates, and water quality. Without such data it will not be possible to evaluate properly the effect of urban, industrial and agricultural developments on groundwater levels, available yield, and groundwater quality. Detailed recommendations as to further data collection are given in the following chapter.

10. RECOMMENDATIONS

10.1 Continuity of Aquifer Zones

The present study has advanced knowledge of the major aquifer zones to the point where a management plan can be effective. Many questions as to geological and hydraulic continuities remain, and some always will remain. The best way to address these uncertainties is to consider them from the point of view of particular groundwater management concerns.

In this context, the hydrogeological points of most concern are:

- a) The continuity of the Condie Aquifer within the Boggy Creek well field area and its interaction with underlying aquifer zones,
- b) The location of the most permeable zones of the Condie Aquifer in the area just south and west of the Boggy Creek well field,
- c) The degree of hydrogeological connection between the Regina Aquifer and the bed of Wascana Creek,
- d) The location of the major aquifer zones within the Zehner Aquifer System which feed the Boggy Creek well field.

These questions can be answered by an appropriate program of test drilling, water-level monitoring and water quality determinations. They will be further discussed in the following sections.

The stratigraphy and hydraulic interconnections of the aquifer zones in the Boggy Creek well field area are far from understood. From a groundwater management point of view, the most important consideration is that the well field is already operating at near its maximum capacity and little change is foreseen. For the time being it may suffice to leave matters at that, paying attention only to the shallowest aquifer zones and the gravel pit reservoirs, which are susceptible to contamina-

tion. Further stratigraphic test drilling would no doubt eventually clarify the hydrogeology of the well field, but such test drilling should only be carried out if it is needed in order to answer specific management concerns.

10.2 Water-Level Data Requirements

The water level data base has been much improved since 1985 with the advent of monthly measurements in selected piezometers, the 1987 "instantaneous piezometric surface" measurements, and the intensive survey of water levels of farm wells north and east of Boggy Creek and Mallory Springs well fields. These data have allowed identification of the major recharge areas which replenish the Regina groundwater supply, as discussed in this report.

In the future, monitoring of water levels in the major aquifer should be done largely by means of continuously recording observation wells. The SRC Regina well has been operating since 1978. In late 1987 the Saskatchewan Water Corporation installed four additional observations wells, two in the Condie Aquifer, one in the Interglacial Sediments of the Regina Aquifer, and one in an Upper Floral aquifer zone of the Zehner Aquifer System (Beckie, 1987). In addition to these, the following locations for more observation wells are recommended, roughly in order of priority:

- a) An observation well completed in a Lower Floral Formation aquifer zone of the Zehner Aquifer System, about 4 to 8 km north-east of Boggy Creek well field. Such a well would monitor water level

conditions in the main recharge area for the Boggy Creek well field.

- b) An observation well completed in an Upper Floral aquifer zone of the Zehner Aquifer System near Boggy Creek in the south-east of Range 18, Township 18. It would monitor recharge by infiltration from Boggy Creek.
- c) An observation well completed in the north-east part of the Regina Aquifer, perhaps at the site of observation well SWC Regina 1 (Beckie, 1987). It would monitor the effects of pumping in the Co-op Refinery area.
- d) An observation well in the Condie Aquifer, to be installed west of new production wells along the east side of Range 19, if such wells are installed (see Section 5.6).
- e) A nest of wells of different depths in the Boggy Creek well field, provided that the stratigraphy and continuity of the aquifer zones in which the wells completed are clearly established, and include the Condie Aquifer.

The program of monthly water-level measurements should be continued and expanded to include some of the wells measured and surveyed for the "instantaneous piezometric surface". New observation wells would eventually replace some of these. It is recommended that the following wells be measured on a monthly basis:

Well	Location	Aquifer
Balgonie Obs 1-75	W2-17-18-07-16-NE	Zehner (U.F1.)
Highways 1-76	W2-18-18-13-01-SE	Zehner (U.F1.)
E85-3	W2-18-17-29-12-NW	Zehner (U.F1.)
CS1 or CS2	W2-18-17-25-05	Condrie
D4-86	W2-18-18-07-07-NW	Zehner
D8	W2-19-18-12-16-NE	Zehner

S8-86	W2-18-18-07-07-SE	Condie ?
OBS 2-81	W2-19-18-10-01-NW	Regina ?
MW 29	W2-19-18-04-08-SW	Condie
MW 44	W2-19-18-03-05-SW	Regina
CAL 303	W2-19-17-32-15-NW	Regina
H21B	W2-19-18-08-12-NW	Regina
BH86-R2-1	W2-20-18-12-16-NW	Condie
H24A	W2-20-18-10-12-NW	Regina
H24B	W2-20-18-10-12-NW	Condie
OBS-W5	W2-20-18-04-09-NW	Regina
Procor TH4-74	W2-20-17-29-02-SE	Regina
Victoria Park	W2-19-17-19-12-SE	Regina (IGS)
I.O.-3B	W2-19-17-32-05-NE	Regina

If monthly measurements are too heavy a workload, then at least quarterly measurements should be done. These water level measurements, together with observations well records, will serve to keep track of the "bank balance" of groundwater resources in the Regina area.

10.3 Data Requirements for Withdrawals.

To date, most data on withdrawals from city wells or well fields are based on hours of running and a rated capacity for each well. The data are therefore subject to considerable error. The meters which are presently being installed on the city wells should rectify the situation.

The withdrawal status of some of the smaller private production wells is not certain. Withdrawals from wells operated by the City Parks Department are also not recorded. All such withdrawals except for domestic wells should be metered and recorded.

It would be very useful for future modelling if withdrawal data for the city wells during 1960-1968 could be located.

More accurate withdrawal data, together with collection of the water level data recommended in the previous section, will also allow

for future refinements of the water balance components of the various aquifers and aquifer systems.

10.4 Well Field Expansions

Boggy Creek well field is operating at near maximum withdrawals and offers little opportunity for expansion. The pumping schedules could be adjusted to reduce losses from flowing wells.

Withdrawals from Mallory Springs well Field and The Edenwold production well PW 85-1 will need to be coordinated since these wells draw from the same aquifer zone.

Water levels in the Regina Aquifer appear to have stabilized over the past 10 years. The present average production level of 4300 dam³ per year can probably be sustained indefinitely, unless recharge to the aquifer is intercepted by other wells. The withdrawals from the aquifer can be increased by installing additional wells in the north-west which would intercept flow now discharging to springs in the Boggy Creek valley.

Mound Springs well field appears to be operating on a sustained yield basis at its present average withdrawal rate of 1900 dam³ per year.

The water resources of the eastern half of the Condie Aquifer are adequate to meet present and future water demands in the area.

Strong lateral flow into the western half of the Condie Aquifer, estimated at 750 to 1500 dam³ per year, could be intercepted by carefully located production wells. Pumping from such wells would produce high quality water and would slow the movement of contaminants further

to the west. It is recommended that this option be evaluated in detail.

10.5 Reduction of Withdrawal Rates

For various reasons it may become attractive or necessary to reduce or cease withdrawals from particular wells or well fields. Such reductions would lead to rising groundwater levels and eventual re-appearance of springs and seeps that may have been dry for many years. The consequences with respect to geotechnical conditions, land-use, contaminant movement, etc. should be considered, before withdrawals are reduced.

10.6 Enhanced and Artificial Recharge

In the south-east of Range 18, Township 18 flow in Boggy Creek could be used to enhance the recharge to the Zehner Aquifer System. The feasibility of such recharge enhancement is not established and would require detailed evaluation.

Artificial recharge may be technically feasible and economically attractive in the area south of Condie. Water from the Buffalo Pound pipeline could be stored within the unsaturated portion of the Condie Moraine during low-use periods and pumped out to meet peak demands. The available storage capacity is very large. It is strongly recommended that this water management option be further evaluated.

10.7 Water Quality Monitoring

Use of groundwater in the presence of known, or potential contamination is likely to become the most difficult management problem in the

future. Withdrawals from the Condie and Regina Aquifers are most at risk. Some contaminant "plumes" have been more or less delineated in the Condie Aquifer, and in particular, well R2 is probably being affected. However, there are undoubtedly other potential sources of contamination, many of them not identified. Attempts to prevent all contamination of the Regina Aquifer would probably be doomed to failure.

It is virtually impossible to predict with certainty if or when the water from a particular well will begin to show contamination. The best course of action may be to continue using the wells, with rigorous water quality monitoring, and to shut a well down if it becomes suspect.

The increasing level of chlorides in well R2 is cause for concern. The water quality for this well should be rigorously checked if it is to remain in use.

10.8 Groundwater Protection

Although protection of the groundwater is a matter of general concern, there are three areas where it is a particular concern. These areas are: (a) the eastern half of the Condie Aquifer, where the sand is exposed at the surface, (b) The bed of Boggy Creek and its watershed in Ranges 17 and 18, above Boggy Creek reservoir, (c) the Condie Moraine in the high area south of Condie. For each of these three areas contamination would effect the natural groundwater resources or use of the aquifer for storage of water by artificial recharge.

Contamination and protection of the groundwater in and near the Regina urban area is a complex and controversial matter. It is conceivable that contamination which has already occurred or is on its way to

the aquifers makes long-term protection of this water an unrealistic goal. In any case the feasibility of such protection should be fully evaluated in a regional context, before expensive remediation or protection measures are undertaken at particular locations.

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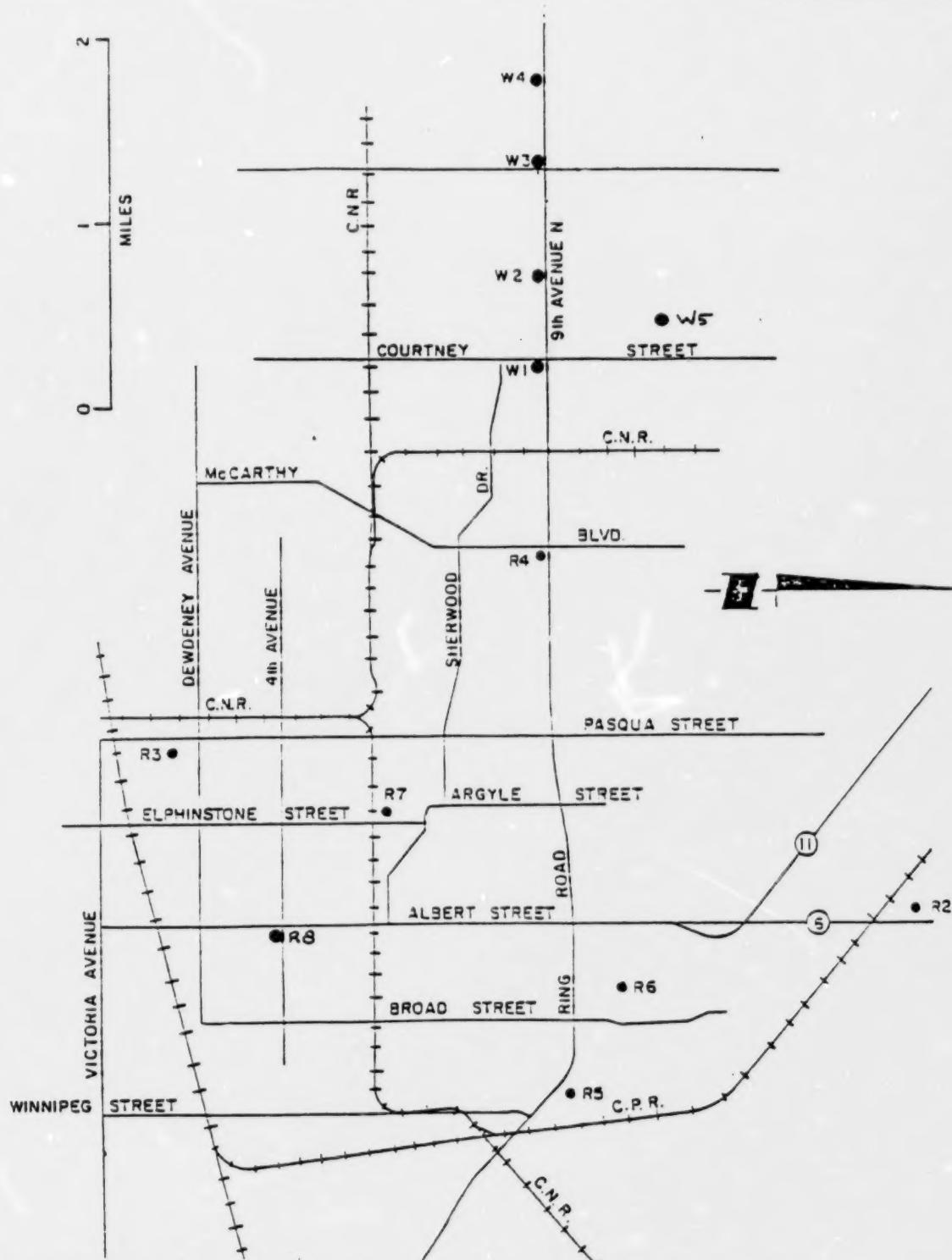
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APPENDIX A
CITY OF REGINA
PRODUCTION WELLS

APPENDIX A - CITY OF REGINA PRODUCTION WELLS

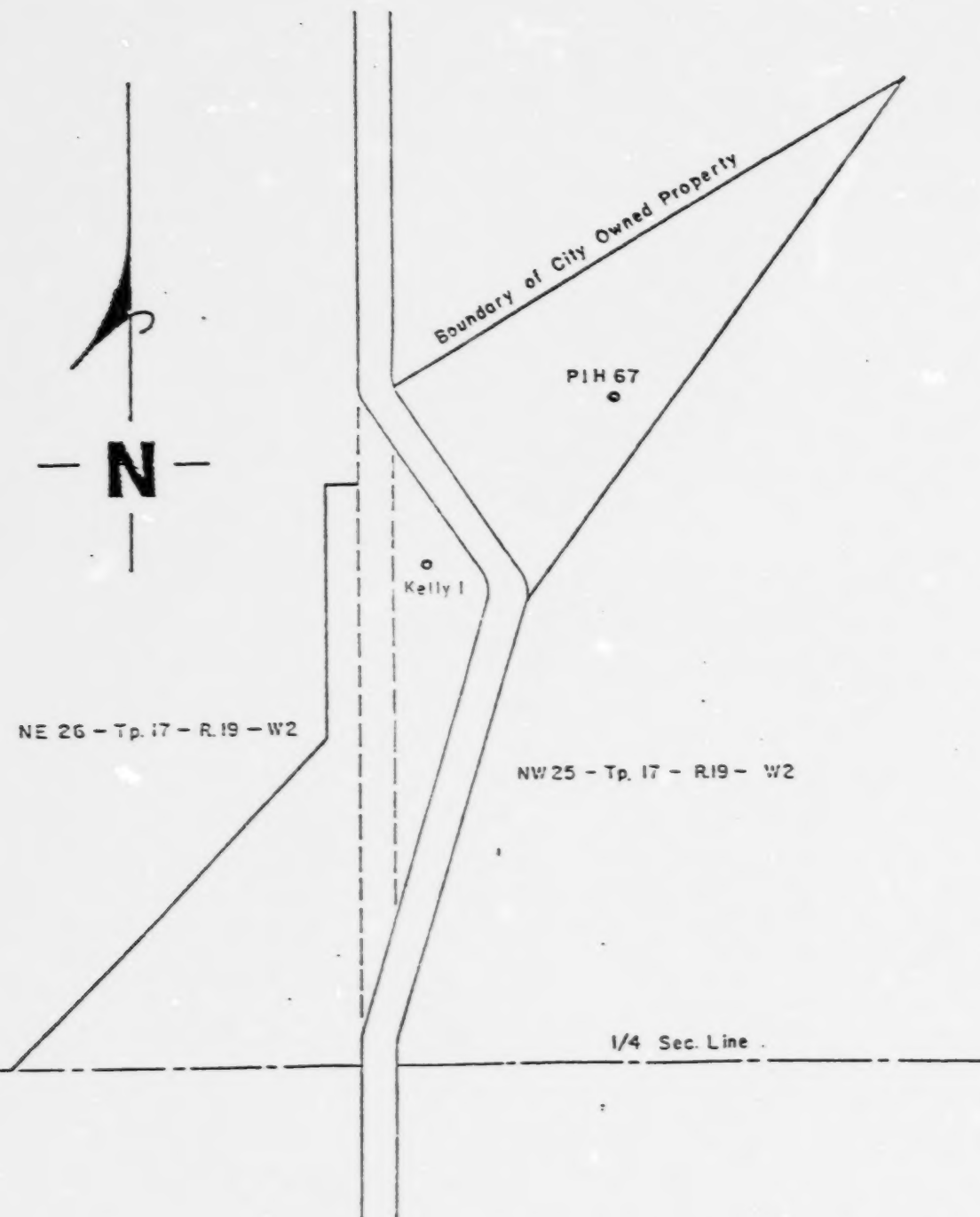
Notes

1. Table A-1 provides a summary of production wells that are or have been in use since about 1930. Some wells that were in use during the period 1930-1969 may have been missed due to lack of records.
2. For more detailed information on well construction, water levels, and water quality see the open-file report by Maathuis and van der Kamp (1988) or Appendices B and D of this report.
3. The well-field location maps are taken from the open-file report by Maathuis and van der Kamp (1988).



(source of map: updated after Associated Engineering Services Ltd., 1981)

LOCATION OF WELLS IN CITY OF REGINA WELL FIELD.



Scale 1 : 3 600

(source of map: City of Regina)

LOCATION OF WELLS IN MALLORY SPRINGS WELL FIELD.

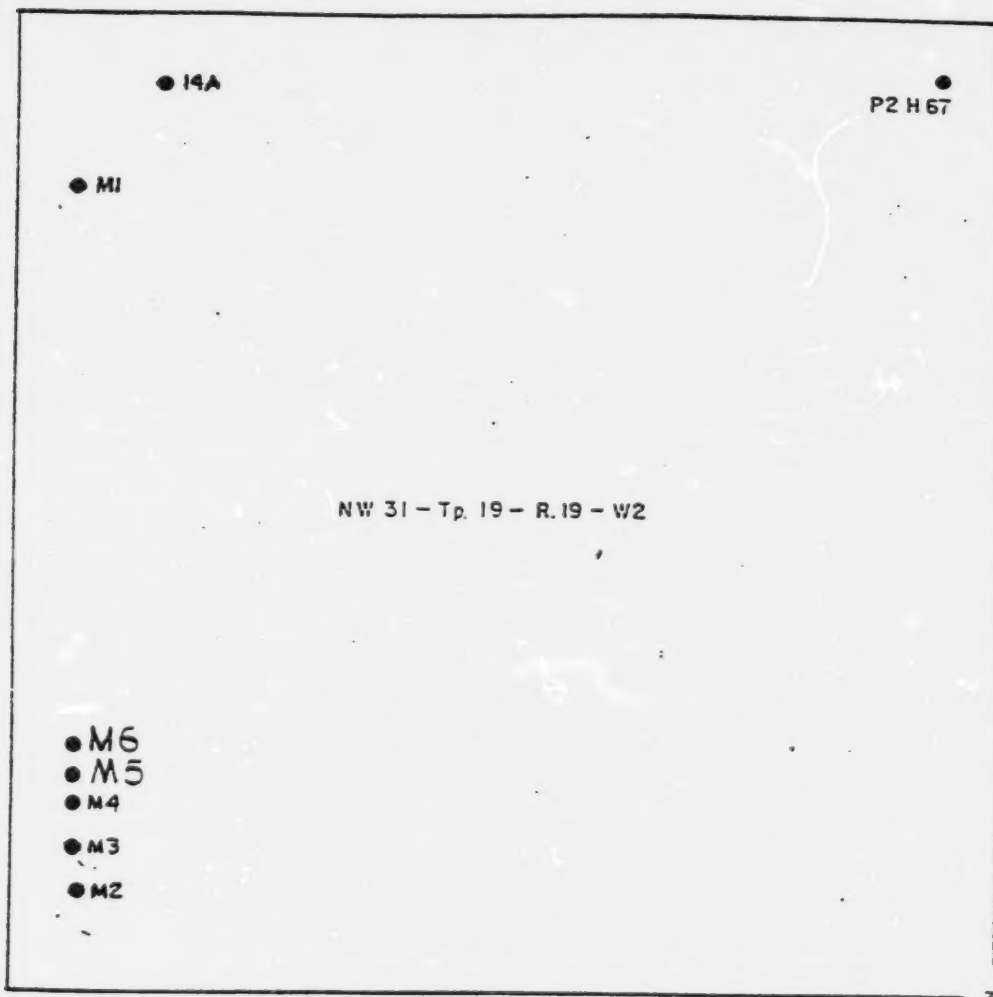


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LOCATION OF WELLS IN BOGGY CREEK WELL FIELD.
(source of map: M.M. Ground Water Engineering Ltd., 1982)



ale 1 : 6 000

(source map: City of Regina)

LOCATION OF WELLS IN MOUND SPRINGS WELL FIELD.

TABLE A-1 LIST OF PRODUCTION WELLS

WELL FIELD	WELL NAME	LOCATION	DATE COMPLETED	DATE TAKEN OUT OF SERVICE	REMARKS
BOGGY CREEK	REG. BC178	W2-18-18-07-04-SW	350908	PRIOR TO 1969	
	REG. BC 6A	W2-18-18-07-07-NE	820511		
	REG. GPW3	W2-18-18-07-07-NE	860421		
	REG. GPW4	W2-18-18-07-07-NE	860429		
	REG. GPW1	W2-18-18-07-07-NW	860403		
	REG. GPW2	W2-18-18-07-07-NW	860418		
	REG. GPW5	W2-18-18-07-07-NW	860508		
	REG. RCW7	W2-18-18-07-07-NW	860420		
	REG. P 60	W2-18-18-07-15-SW	600630	1977	REPLACED BY BC 5
	REG. RC 5	W2-18-18-07-15-NE	770426		
	REG. BC K3	W2-19-18-12-12-NE	29		ALSO LISTED AS BC 168
	REG. BC-2	W2-19-18-12-13-NW	6203		
	REG. RC 3	W2-19-18-12-07-NW	62		
	REG. BC166	W2-19-18-12-07-NW	3007		
	REG. BC179	W2-19-18-13-SE	3509	PRIOR TO 1969	TRANSFERRED TO PARKS DEPARTMENT 1987
	REG. RC191	W2-19-18-13-02-SE	440712	1976	REPLACED BY BC-4
	REG. BC-4	W2-19-18-13-02-SE	760203		
	REG. BC192	W2-19-18-13-05-SE	490720		
MALLORY SPRINGS	REG. K1	W2-19-17-25-12 NW	29		

TABLE A-1 LIST OF PRODUCTION WELLS (CONTINUED)

WELL FIELD	WELL NAME	LOCATION	DATE COMPLETED	DATE TAKEN OUT OF SERVICE	REMARKS
MOUND SPRINGS	REG. K2	W2-19-17-25-12-NW	29	PRIOR TO 1969	
	REG. P1	W2-19-17-25-12-NW	670304		
	9G	W2-19-19-31-12-SE	4409	PRIOR TO 1969	
	REG. P2	W2-19-19-31-14-NE	670422		
	REG. 14A	W2-19-19-31-13-NW	4008		
	REG. M1	W2-19-19-31-13-NW	6209	1984	
	REG. M2	W2-19-19-31-12-SW	6209	1984	
	REG. M3A	W2-19-19-31-12-SW	6210		
	REG. M4	W2-19-19-31-12-SW	6210		
	REG. M5	W2-19-19-31-NW	6210	PRIOR TO 1969	
REGINA CITY WELL FIELD	REG. M6	W2-19-19-31-NW	620912	PRIOR TO 1969	
	WELL NO. 2	W2-19-17-30-10	29	PRIOR TO 1969	IN CITY YARD
	C4	W2-19-17-30-NE	4808	1977	
	PD NO. 1	W2-19-17-19-NW	5004	?	VICTORIA PARK
	PD NO. 2	W2-19-17-30-SW	5806		4TH AVE CEMETERY
	REG. R8	W2-19-17-30-12-SW	8211		
	REG. R5	W2-19-18-06-01-SE	6801		
	REG. R6	W2-19-18-06-06-NE	6802		
	REG. R3	W2-20-17-24-13-SW	600822		
	REG. W4	W2-20-17-32-15-NW	6112		

TABLE A-1 LIST OF PRODUCTION WELLS (CONTINUED)

WELL FIELD	WELL NAME	LOCATION	DATE COMPLETED	DATE TAKEN OUT OF SERVICE	REMARKS
	REG. W3	W2 20 17-32-16 NE	6202		
	REG. W2	W2-20-17-33-15-NW	6303	?	
	REG. W1	W2-20-17-33-16-NE	6303		
	REG. R4	W2-20-17-35-13-NW	610628	8404	
	REG. R7	W2 20-17-36-03 SW	6802		
	REG. W5	W2-20-18-04-09 NW	8304		
	REG. R2	W2 20 18-12-16 NW	600707		

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY

LAND LOCATION	DATE	WELL NAME	DEPTH M	PH	CA MG/L	MG	NA MG/L	K	PE MG/L	MN MG/L	HC03 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM IONS MG/L	T.H. MG/L	T.A. MG/L	SUM CAT. EPM	SUM ANI. EPM	ERROR BAL.	REFERENCE
W2-19-17-25-12-NW 670309	P1	42.7	123	63	44	6					444	290	4		974	564	364	13.23	13.43	0.75	MOLLARD, 1967
W2-19-17-25-12-NW 800600	P1	42.7	7.9	120	59	49			0.7	0.92	389	389	2	1	1011	544	319	12.97	14.53	5.67	AESL, 1981
W2-19-17-25-12-NW 800700	P1	42.7	7.3	121	57	46			0.5	0.98	442	268	2	1	938	540	362	12.73	12.88	0.60	AESL, 1981
W2-19-17-25-12-NW 830728	P1	42.7	7.5	117	63	46			0.5	0.88	447	266	8	<1	948	552	366	13.02	13.09	0.26	CITY OF REGINA
W2-19-17-25-12-NW 840724	P1	42.7	7.5	126	57	40			0.5	1.00	440	260	6	<1	931	552	361	12.72	12.79	0.30	CITY OF REGINA
W2-19-17-25-12-NW 860722	P1	42.7	7.6	117	61	45			<0.1	0.86	444	250	8	<1	926	544	364	12.81	12.71	-0.41	CITY OF REGINA
NO. SAMPLES				5.0	6	6	6	1	5	5	6	6	6	5	6	6	6				
MAXIMUM				7.9	126	63	49		0.7	1.00	447	389	8		1011	564	366				
MINIMUM				7.3	117	57	40		0.0	0.86	389	250	2		926	540	319				
AVERAGE				7.6	121	60	46		0.4	0.93	434	287	5		955	549	356				
ST. DEV.				0.2	3	3	3		0.2	0.05	20	47	3		30	8	17				
NOTE: THE SULPHATE CONCENTRATION OF THE 800600 ANALYSIS IS EITHER A TYPOGRAPHICAL OR ANALYTICAL ERROR																					
W2-19-17-25-12-NW 660000	K1	42.4	126	54	44	7				0.80	506	229	4		971	539	415	12.64	13.17	2.05	MOLLARD, 1966
W2-19-17-25-12-NW 800600	K1	42.4	7.4	107	61	50			0.2	0.82	421	280	4	<1	924	520	345	12.53	12.84	1.22	AESL, 1981
W2-19-17-25-12-NW 800600	K1	42.4	7.2	118	55	46			0.3	0.89	410	260	2	3	895	524	336	12.41	12.19	-0.91	AESL, 1981
W2-19-17-25-12-NW 860722	K1	42.2	7.6	115	62	46			0.5	0.81	445	250	14	<1	933	544	365	12.84	12.89	0.21	CITY OF REGINA
NO. SAMPLES				3	4	4	4	1	3	4	4	4	4	3	4	4	4				
MAXIMUM				7.6	126	62	50		0.5	0.89	506	280	14		971	544	415				
MINIMUM				7.2	107	54	44		0.2	0.80	410	229	2		895	520	336				
AVERAGE				7.4	117	58	47		0.3	0.83	446	255	6		931	532	365				
ST. DEV.				0.2	7	4	2		0.1	0.04	37	18	5		27	10	31				
W2-19-19-31-14-NE 670323	P2	49.1	7.2	190	109	73	9				682	508	9		1580	925	560	21.62	22.01	0.88	MOLLARD, 1967b
W2-19-19-31-14-NE 670324	P2	49.1	7.1	198	101	70	8		3.4	1.00	684	495	10		1570	912	561	21.23	21.80	1.31	MOLLARD, 1967b
W2-19-19-31-14-NE 800600	P2	49.1	7.4	176	105	74			1.6	0.78	686	488	6	<1	1517	872	547	20.64	21.25	1.45	AESL, 1981
W2-19-19-31-14-NE 800600	P2	49.1	7.3	165	113	66			3.5	0.71	656	492	12	<1	1508	876	538	20.40	21.33	2.24	AESL, 1981
W2-19-19-31-14-NE 830726	P2	49.1	7.4	180	104	72			2.7	0.76	676	460	10	<1	1535	904	554	21.17	21.36	0.44	CITY OF REGINA
W2-19-19-31-14-NE 840724	P2	49.1	7.2	194	114	67			1.0	0.87	687	432	10	<1	1486	952	547	21.97	20.21	-4.18	CITY OF REGINA
W2-19-19-31-14-NE 860722	P2	49.1	7.3	174	113	71			0.7	0.75	707	450	12	<1	1528	900	558	21.07	21.30	0.54	CITY OF REGINA
NO. SAMPLES				7	7	7	7	2	6	6	7	7	7	5	7	7	7				
MAXIMUM				7.4	198	114	74		3.5	1.00	707	508	12		1580	952	561				

LAND LOCATION	DATE VYNNDD	WELL NAME	DEPTH M	PH	CA MG/L	MG	NA MG/L	K	FE MG/L	MN MG/L	HC03 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM MG/L	T.H. MG/L	T.A. SUM MG/L	SUM EPM	ERROR BAL.	REFERENCE
MINIMUM				7.1	165	101	66		0.7	0.71	656	432	6		1486	872	538			
AVERAGE				7.3	184	108	70		2.1	0.81	677	478	10		1532	906	552			
ST.DEV.				0.1	11	5	3		1.1	0.10	15	25	2		31	26	8			
W2-19-19-31-13-NW 800300	M1	42.1	7.3	170	102	75			3.0	0.75	646	436	6	<1	1439	844	530	20.14	19.83	-0.75 CITY OF REGINA
W2-19-19-31-13-NW 800600	M1	42.1	7.1	168	92	70			2.7	1.44	600	452	6	<1	1392	864	492	19.00	19.41	1.09 AESL, 1981
W2-19-19-31-13-NW 800700	M1	42.1	7.1	166	109	66			2.5	0.80	608	488	4	5	1449	864	498	20.12	20.24	0.29 AESL, 1981
NO. SAMPLES				3	3	3	3		3	3	3	3	3	3	3	3	3			
MAXIMUM				7.3	170	109	75		3.0	1.44	646	488	6		1449	864	530			
MINIMUM				7.1	166	92	66		2.5	0.75	600	436	4		1392	844	492			
AVERAGE				7.2	168	101	70		2.7	1.00	618	459	5		1427	857	507			
ST.DEV.				0.1	2	7	4		0.2	0.31	20	22	1		25	9	17			
W2-19-19-31-12-SW 660000	M2	26.3	7.6	143	78	59	8			1.00	550	350	8		1197	678	451	16.12	16.53	1.25 MOLLARD, 1966
W2-19-19-31-12-SW 800300	M2	26.3	7.6	117	75	51			0.2	1.26	510	262	4		1020	600	418	14.23	13.93	-1.06 CITY OF REGINA
W2-19-19-31-12-SW 800600	M2	26.3	7.4	120	78	51			<0.1	1.01	495	292	4	<1	1041	620	406	14.62	14.31	-1.10 AESL, 1981
W2-19-19-31-12-SW 800700	M2	26.3	7.2	120	79	52			0.9	1.16	489	300	10	<1	1052	624	401	14.75	14.54	-0.70 AESL, 1981
NO. SAMPLES				4	4	4	4	1	3	4	4	4	4	2	4	4	4			
MAXIMUM				7.6	143	79	59		0.9	1.26	550	350	10		1197	678	451			
MINIMUM				7.2	117	75	51		0.0	1.00	489	262	4		1020	600	401			
AVERAGE				7.5	125	78	53		0.4	1.11	511	301	7		1078	631	419			
ST.DEV.				0.2	10	2	3		0.4	0.11	24	32	3		70	29	19			
W2-19-19-31-12-SW 800300	M3A	33.7	7.5	122	80	42			<0.1	1.26	483	284	6	<1	1018	632	396	14.50	14.00	-1.74 CITY OF REGINA
W2-19-19-31-12-SW 800600	M3A	33.7	7.2	131	78	46			<0.1	1.06	460	320	10	<1	1046	648	377	14.95	14.48	-1.60 AESL, 1981
W2-19-19-31-12-SW 800600	M3A	33.7	7.6	332	70	42			0.2	0.12	456	320	6	<1	1226	620	374	24.15	14.31	-25.60 AESL, 1981
W2-19-19-31-12-SW 830728	M3A	33.7	7.4	126	68	45			<0.1	1.14	481	284	12	<1	1017	596	394	13.84	14.13	

LAND LOCATION	DATE YYMMDD	WELL NAME	DEPTH M	PH	CA MG/L	MG	NA MG/L	K	FE MG/L	MN MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM MG/L	T.H. MG/L	T.A. SUM MG/L	CAT. EPM	SUM ANI.	ERROR BAL.	REFERENCE
MINIMUM				7.1	165	101	66		0.7	0.71	656	432	6		1486	872	538				
AVERAGE				7.3	184	108	70		2.1	0.81	677	478	10		1532	906	552				
ST.DEV.				0.1	11	5	3		1.1	0.10	15	25	2		31	26	8				
W2-19-19-31-13-NW 800300	M1	42.1	7.3	170	102	75			3.0	0.75	646	436	6	<1	1439	844	530	20.14	19.83	-0.75	CITY OF REGINA
W2-19-19-31-13-NW 800600	M1	42.1	7.1	168	92	70			2.7	1.44	600	452	6	<1	1392	864	492	19.00	19.41	1.09	AESL, 1981
W2-19-19-31-13-NW 800700	M1	42.1	7.1	166	109	66			2.5	0.80	608	488	4	5	1449	864	498	20.12	20.24	0.29	AESL, 1981
NO. SAMPLES				3	3	3	3		3	3	3	3	3	3	3	3	3				
MAXIMUM				7.3	170	109	75		3.0	1.44	646	488	6		1449	864	530				
MINIMUM				7.1	166	92	66		2.5	0.75	600	436	4		1392	844	492				
AVERAGE				7.2	168	101	70		2.7	1.00	618	459	5		1427	857	507				
ST.DEV.				0.1	2	7	4		0.2	0.31	20	22	1		25	9	17				
W2-19-19-31-12-SW 660000	M2	26.3	7.6	143	78	59	8			1.00	550	350	8		1197	678	451	16.12	16.53	1.25	MOLLARD, 1966
W2-19-19-31-12-SW 800300	M2	26.3	7.6	117	75	51			0.2	1.26	510	262	4		1020	600	418	14.23	13.93	-1.06	CITY OF REGINA
W2-19-19-31-12-SW 800600	M2	26.3	7.4	120	78	51			<0.1	1.01	495	292	4	<1	1041	620	406	14.62	14.31	-1.10	AESL, 1981
W2-19-19-31-12-SW 800700	M2	26.3	7.2	120	79	52			0.9	1.16	489	300	10	<1	1052	624	401	14.75	14.54	-0.70	AESL, 1981
NO. SAMPLES				4	4	4	4	1	3	4	4	4	4	2	4	4	4				
MAXIMUM				7.6	143	79	59		0.9	1.26	550	350	10		1197	678	451				
MINIMUM				7.2	117	75	51		0.0	1.00	489	262	4		1020	600	401				
AVERAGE				7.5	125	78	53		0.4	1.11	511	301	7		1078	631	419				
ST.DEV.				0.2	10	2	3		0.4	0.11	24	32	3		70	29	19				
W2-19-19-31-12-SW 800300	M3A	33.7	7.5	122	80	42			<0.1	1.26	483	284	6	<1	1018	632	396	14.50	14.00	-1.74	CITY OF REGINA
W2-19-19-31-12-SW 800600	M3A	33.7	7.2	131	78	46			<0.1	1.06	460	320	10	<1	1046	648	377	14.95	14.48	-1.60	AESL, 1981
W2-19-19-31-12-SW 800600	M3A	33.7	7.6	332	70	42			0.2	0.12	456	320	6	<1	1226	620	374	24.15	14.31	-25.60	AESL, 1981
W2-19-19-31-12-SW 830728	M3A	33.7	7.4	126	68	45			<0.1	1.14	481	284	12	<1	1017	596	394	13.84	14.13	1.06	CITY OF REGINA
W2-19-19-31-12-SW 840724	M3A	33.7	7.7	130	76	45			0.3	1.24	492	280	10	<1	1035	636	403	14.70	14.18	-1.80	CITY OF REGINA
W2-19-19-31-12-SW 860722	M3A	33.7	7.5	117	66	42			<0.1	0.98	495	242	10	<1	973	564	393	13.09	13.43	1.28	CITY OF REGINA
NO. SAMPLES				6	6	6	6		6	6	6	6	6	6	6	6	6				
MAXIMUM				7.7	332	80	46		0.3	1.26	495	320	12		1226	648	403				
MINIMUM				7.2	117	66	42		0.0	0.12	456	242	6		973	564	374				

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE	WELL NAME	DEPTH M	PH	CA MG/L	MG	NA MG/L	K MG/L	FE MG/L	MN MG/L	HCO ₃ MG/L	SO ₄ MG/L	CL MG/L	NO ₃ MG/L	SUM IONS MG/L	T.H. MG/L	T.A. MG/L	SUM EPM	SUM ANI.	ERROR BAL.	REFERENCE
AVERAGE	7.5	160	73	44	0.1	0.97	478	288	9	1053	616	300									
ST. DEV.	0.2	77	5	2	0.1	0.39	15	27	2	81	28	10									
NOTE: THE CA CONCENTRATION OF SECOND 800600 ANALYSIS IS EITHER A TYPOGRAPHICAL OR ANALYTICAL ERROR																					
W2-19-19-31-12-SW 660000	M4	28.7	7.5	158	81	55	8			1.70	525	396	13		1238	727	431	16.94	17.22	0.81	MOLLARD, 1966
W2-19-19-31-12-SW 800600	M4	28.7	7.4	181	106	66			0.7	1.12	571	506	14	<1	1446	888	488	20.62	20.29	-0.82	AESL, 1981
W2-19-19-31-12-SW 800600	M4	28.7	7.3	195	110	75			0.3	2.30	622	560	28	5	1598	940	510	22.04	22.64	1.35	AESL, 1981
W2-19-19-31-12-SW 830728	M4	28.7	7.4	170	90	63				1.62	558	440	12	<1	1335	796	457	18.63	18.64	0.05	CITY OF REGINA
W2-19-19-31-12-SW 840724	M4	28.7	7.5	158	96	70			1.0	0.58	538	440	10	<1	1314	792	441	18.83	18.26	-1.52	CITY OF REGINA
W2-19-19-31-12-SW 860722	M4	28.7	7.5	155	86	59			<0.1	1.44	565	390	14	<1	1270	740	446	17.38	17.77	1.14	CITY OF REGINA
NO. SAMPLES	6	6	6	6	1	4	6	6	5	6	6	6	6	5	6	6	6				
MAXIMUM	7.5	195	110	75	1.0	2.30	622	560	28	1598	940	510			1238	727	431				
MINIMUM	7.3	155	81	55	0.0	0.58	525	390	10	1367	814	462									
AVERAGE	7.4	170	95	65	0.5	1.46	563	455	15	122	77	28									
ST. DEV.	0.1	14	10	7	0.4	0.53	31	60	6												
W2-19-19-31-13-NW 660000	14A	45.1	7.6	193	106	70	8	8			678	480	4		1545	915	558	21.40	21.22	-0.41	MOLLARD, 1966
W2-19-19-31-13-NW 660000	14A	45.1	7.7	190	104	73				1.10	555	543	10		1484	903	455	21.21	20.68	-1.26	MOLLARD, 1966
W2-19-19-31-13-NW 800300	14A	45.1	7.3	200	96	72			3.8	0.81	700	444	10	<1	1527	896	574	21.01	21.00	-0.02	CITY OF REGINA
W2-19-19-31-13-NW 800600	14A	45.1	7.4	184	102	76			3.6	1.44	666	478	10	<1	1521	880	546	20.88	21.15	0.65	AESL, 1981
W2-19-19-31-13-NW 830728	14A	45.1	7.4	198	107	75			1.1	0.83	671	492	10	<1	1555	936	550	21.94	21.52	-0.97	CITY OF REGINA
W2-19-19-31-13-NW 840724	14A	45.1	7.3	186	99	70			1.2	0.82	653	448	12	<1	1470	872	535	20.47	20.37	-0.25	CITY OF REGINA
W2-19-19-31-13-NW 860722	14A	45.1	7.5	181	108	70			0.6	0.66	672	480	14	<1	1526	896	551	20.96	21.40	1.04	CITY OF REGINA
NO. SAMPLES	7	7	7	7	2	6	6	6	7	7	7	7	7	5	7	7	7				
MAXIMUM	7.7	200	108	76	5.8	1.44	700	543	14	1555	936	574									
MINIMUM	7.3	181	96	70	0.6	0.66	555	444	4	1470	872	455									
AVERAGE	7.5	190	103	72	2.7	0.94	656	481	10	1518	900	538									
ST. DEV.	0.1	7	4	2	1.9	0.26	43	30	3	28	20	36									
W2-19-18-12-13-NW 660000	BC-2	32.6	7.3	171	76	41	6				539	376	4		1213	737	442	16.57	16.78	0.62	MOLLARD, 1966

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE YYMMDD	WELL NAME	DEPTH M	PH	CA MG/L	MG	NA MG/L	K MG/L	FE MG/L	MN MG/L	HC03 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM IONS MG/L	T.H. MG/L	T.A. MG/L	SUM CAT. EPM	ERROR ANI.	REFERENCE BAL.
W2-19-18-12-13-NW 660000	BC-2	32.6	8.1	72	80	44	7	0.5	0.90	241	370	4	819	511	197	12.09	11.77	-1.35	MOLLARD, 1966	
W2-19-18-12-13-NW 800600	BC-2	32.6	7.3	187	91	71	0.3	1.62	489	560	8	<1	1408	844	401	19.91	19.90	-0.01	AESL, 1981	
W2-19-18-12-13-NW 830728	BC-2	32.6	7.3	203	109	70	0.3	1.45	624	600	16	<1	1624	956	512	22.14	23.17	2.27	CITY OF REGINA	
W2-19-18-12-13-NW 840724	BC-2	32.6	7.7	197	98	64	0.3	1.66	606	530	14	<1	1511	896	497	20.68	21.36	1.63	CITY OF REGINA	
W2-19-18-12-13-NW 860723	BC-2	32.6	7.2	200	102	70	<0.1	1.48	614	520	14	<1	1521	920	503	21.42	21.28	-0.31	CITY OF REGINA	
NO. SAMPLES			6	6	6	6	2	5	5	6	6	6	4	6	6					
MAXIMUM			8.1	203	109	71	0.5	1.66	624	600	16	1624	956	512						
MINIMUM			7.2	72	76	41	0.0	0.90	241	370	4	819	511	197						
AVERAGE			7.5	172	93	60	0.3	1.42	519	493	10	1349	811	425						
ST. DEV.			0.3	46	12	13	0.2	0.27	133	88	5	269	151	109						
NOTE: SECOND 660000 ANALYSIS SUGGESTS CAC03 MAY HAVE BEEN PRECIPITATED IN BOTTLE PRIOR TO ANALYSIS																				
W2-19-18-12-07-NW 800600	BC-3	48.8	7.6	86	56	45	0.3	0.64	381	228	6	<1	803	448	312	10.86	11.16	1.39	AESL, 1981	
W2-19-18-12-07-NW 800700	BC-3	48.8	7.4	102	56	43	0.6	0.48	425	227	2	<1	856	488	348	11.57	11.75	0.78	AESL, 1981	
W2-19-18-12-07-NW 830728	BC-3	48.8	7.5	114	57	42	0.6	0.87	436	238	6	<1	894	520	357	12.20	12.27	0.27	CITY OF REGINA	
W2-19-18-12-07-NW 840724	BC-3	48.8	7.8	118	58	40	0.6	1.36	433	240	6	<1	897	536	355	12.40	12.26	-0.55	CITY OF REGINA	
W2-19-18-12-07-NW 860723	BC-3	48.8	7.4	118	59	41	<0.1	0.64	441	248	10	<1	918	540	362	12.53	12.67	0.59	CITY OF REGINA	
NO. SAMPLES			5	5	5	5	5	5	5	5	5	5	5	5	5					
MAXIMUM			7.8	118	59	45	0.6	1.36	441	248	10	918	540	362						
MINIMUM			7.4	86	56	40	0.0	0.48	381	227	2	803	448	312						
AVERAGE			7.5	108	57	42	0.4	0.76	423	236	6	874	506	347						
ST. DEV.			0.1	12	1	2	0.2	0.31	22	8	3	41	34	18						
NOTE: THE 800600 ANALYSIS SUGGESTS CAC03 MAY HAVE BEEN PRECIPITATED IN BOTTLE PRIOR TO ANALYSIS																				
W2-19-18-13-02-SE 660000	191	43.9	137	63	34	6	461	282	4	987	600	378	13.50	13.54	0.16	MOLLARD, 1966				
W2-19-18-13-02-SE 660000	191	43.9	130	57	41	6	438	252	4	930	559	359	12.96	12.54	-1.65	MOLLARD, 1966				
NOTE: IN 1976 WELL 191 WAS REPLACED BY WELL BC-4																				
W2-19-18-13-02-SE 800600	BC-4	42.7	7.4	136	68	36	0.4	1.24	467	320	8	1037	620	383	13.95	14.54	2.09	AESL, 1981		
W2-19-18-13-02-SE 800700	BC-4	42.7	7.5	122	72	39	0.3	1.12	409	320	4	967	600	330	13.71	13.48	-0.84	AESL, 1981		

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE YYMMDD	WELL NAME	DEPTH M	PH	CA MG/L	MG MG/L	NA MG/L	K	FE MG/L	MN MG/L	HC03 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM IONS MG/L	T.H. MG/L	T.A. SUM MG/L CAT.	SUM EPM	ERROR BAL.	REFERENCE
W2-19-18-13-02-SE 830728	BC-4	42.7	7.4	141	74	5	5	5	0.4	1.08	475	292	10	<1	1032	656	389	14.82	14.15	-2.32 CITY OF REGINA
W2-19-18-13-02-SE 840724	BC-4	42.7	7.7	146	69	34	34	0.4	1.10	472	300	6	<1	1029	648	387	14.44	14.5	-1.01 CITY OF REGINA	
W2-19-18-13-02-SE 860723	BC-4	42.7	7.5	136	65	34	34	<0.1	0.90	464	278	8	<1	986	608	381	13.61	13.62	0.02 CITY OF REGINA	
NO. SAMPLES	5	5	5	5	5	5	5	5	5	5	5	5	5	3	5	5	5			
MAXIMUM	7.7	146	74	39	0.4	1.24	475	320	10	1037	656	389								
MINIMUM	7.4	122	65	34	0.0	0.90	409	278	4	967	600	330								
AVERAGE	7.5	136	70	36	0.3	1.09	457	302	7	1010	628	374								
ST. DEV.	0.1	8	3	2	0.2	0.11	24	16	2	28	22	22								
W2-18-18-07-15-SW 660000	P60	57.9	153	71	48	8	8	1.6	1.80	484	358	8	1132	694	397	15.56	15.61	0.16	MOLLARD, 1966	
W2-18-18-07-15-SW 660000	P60	57.9	169	74	50	8	8	1.80	499	380	7	1189	703	409	16.70	16.29	-1.24	MOLLARD, 1966		
NOTE: IN 1977 WELL P60 WAS REPLACED BY WELL BC-5																				
W2-18-18-07-15-NE 800300	BC-5	57.9	7.5	139	79	51	51	0.8	0.89	522	344	2	<1	1139	672	428	15.65	15.77	0.38	CITY OF REGINA
W2-18-18-07-15-NE 800600	BC-5	57.9	7.4	147	79	54	54	0.3	0.92	504	392	2	<1	1179	692	413	16.18	16.48	0.90	AESL, 1981
W2-18-18-07-15-NE 800600	BC-5	57.9	7.5	138	78	55	55	0.9	0.83	490	390	4	<1	1157	694	402	15.89	16.26	1.78	AESL, 1981
W2-18-18-07-15-NE 830728	BC-5	57.9	7.3	162	77	56	56	0.7	0.86	516	392	8	<1	1213	720	423	16.85	16.84	-0.03	CITY OF REGINA
W2-18-18-07-15-NE 840724	BC-5	57.9	7.7	166	79	50	50	0.7	0.98	515	408	4	<1	1224	740	422	16.96	17.05	0.27	CITY OF REGINA
W2-18-18-07-15-NE 860723	BC-5	57.9	7.5	165	81	56	56	<0.1	0.81	535	392	8	<1	1238	744	439	17.33	17.16	-0.51	CITY OF REGINA
NO. SAMPLES	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6			
MAXIMUM	7.7	166	81	56	0.9	0.98	535	408	8	1238	744	439								
MINIMUM	7.3	138	77	50	0.0	0.81	490	344	2	1139	664	402								
AVERAGE	7.5	153	79	54	0.6	0.88	514	386	5	1191	705	421								
ST. DEV.	0.1	12	1	2	0.3	0.06	14	20	2	36	31	12								
W2-18-18-07-09-SE 830728	BC-6A	69.0	7.4	115	55	35	35	0.3	0.69	432	218	4	<1	860	516	354	11.79	11.73	-0.23	CITY OF REGINA
W2-18-18-07-09-SE 840724	BC-6A	69.0	7.3	117	57	33	33	0.4	0.80	442	244	6	<1	900	528	362	11.96	12.49	2.17	CITY OF REGINA
W2-18-18-07-09-SE 860723	BC-6A	69.0	7.5	128	65	40	40	<0.1	0.75	461	274	8	<1	977	588	378	13.47	13.49	0.04	CITY OF REGINA
NO. SAMPLES	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3			
MAXIMUM	7.5	128	65	40	0.4	0.80	461	274	8	977	588	378								
MINIMUM	7.3	115	55	33	0.0	0.69	432	218	4	860	516	354								

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE	WELL	DEPTH	PH	CA	MG/L	MG/L	NA	K	PE	MM	HC03	SO4	CL	NO3	SUM	T.H.	T.A.	SUM	SUM	ERROR	REFERENCE
	YINMDD	NAME	M						MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	IONS	MG/L	MG/L	MG/L	ANI.	BAL.	
																			EPN	EPN	%	
AVERAGE	7.4	120	59	36						0.2	0.75	445	245	6		912	544	365				
ST. DEV.	0.1	6	4	3						0.2	0.04	12	23	2		48	31	10				
W2-19-18-12-07-NW 660000 BC-166 14.6	7.7	152	40	9	4					0.90	412	255		4		877	545	338	11.27	12.17	3.87	MOLLARD, 1966
W2-19-18-12-07-NW 800300 BC-166 14.6	7.2	147	42	8						15.0	349	268		2		832	540	286	11.14	11.36	0.97	CITY OF REGINA
W2-19-18-12-07-NW 800600 BC-166 14.6	7.4	139	45	10						3.1	0.83	337	264	4		803	532	276	11.07	11.13	0.27	AESL, 1981
W2-19-18-12-07-NW 800600 BC-166 14.6	7.3	104	46	9						4.1	0.12	205	264	2		634	448	168	9.37	8.91	-2.47	AESL, 1981
W2-19-18-12-07-NW 830728 BC-166 14.6	7.5	154	43	8						3.3	0.87	298	276	10		793	580	240	11.57	10.91	-2.92	CITY OF REGINA
W2-19-18-12-07-NW 840724 BC-166 14.6	7.4	163	41	6						1.2	0.90	338	276	14		840	576	277	11.77	11.68	-0.37	CITY OF REGINA
W2-19-18-12-07-NW 860723 BC-166 14.6	7.4	149	42	5						0.5	0.73	335	250	10		792	544	274	11.11	10.98	-0.59	CITY OF REGINA
NO. SAMPLES	7	7	7	7	1	6	7	7	7	7	7	7	7	7	6	7	7	7	7			
MAXIMUM	7.7	163	46	10						15.0	0.90	412	276	14		877	580	338				
MINIMUM	7.2	104	40	5						0.5	0.12	205	250	2		634	448	168				
AVERAGE	7.4	144	43	8						4.5	0.75	325	265	7		706	538	266				
ST. DEV.	0.1	18	2	2						4.8	0.26	58	9	4		72	40	48				
NOTE: SECOND 800600 ANALYSIS SUGGESTS CAC03 MAY HAVE BEEN PRECIPITATED IN BOTTLE PRIOR TO ANALYSIS																						
W2-19-18-13-05-SE 800600 BC-192 32.3	7.6	186	112	63						0.1	0.00	622	530	4		1518	924	510	21.24	21.34	0.25	AESL, 1981
W2-19-18-13-05-SE 830728 BC-192 32.3	7.2	211	108	69						0.8	1.74	637	560	14		1602	972	522	22.41	22.49	0.18	CITY OF REGINA
W2-19-18-13-05-SE 840724 BC-192 32.3	7.4	211	110	65						0.7	1.60	632	560	14		1594	980	518	22.41	22.41	0.02	CITY OF REGINA
W2-19-18-13-05-SE 860723 BC-192 32.3	7.4	205	108	69						<0.1	1.52	650	525	12		1571	956	533	22.12	21.92	-0.44	CITY OF REGINA
NO. SAMPLES	3	3	3	3						3	3	3	3	3	3	27	3	3	3			
MAXIMUM	7.6	211	112	69						0.8	1.74	637	560	14		1606	980	522				
MINIMUM	7.2	186	108	63						0.1	0.66	622	530	4		1514	924	510				
AVERAGE	7.4	203	110	66						0.5	1.33	630	550	11		1571	959	517				
ST. DEV.	0.2	12	2	2						0.3	0.48	6	14	5		42	25	5				
NOTE: THE 800600 ANALYSIS IS TAKEN AS THE ANALYSIS FOR WELL 197 IN THE AESL REPORT (1981, TABLE 7)																						
W2-19-18-12-12-NE 660000 BC-K3 29.9	7.5	160	80	43	7					0.2	1.20	514	384	4		1192	730	422	16.44	16.53	0.29	MOLLARD, 1966
W2-19-18-12-12-NE 660000 BC-K3 29.9	7.7	165	77	41	7							517	382	7		1197	727	424	16.35	16.62	0.83	MOLLARD, 1966

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE	WELL	DEPTH	PH	CA	MG/L	MG/L	NA	K	FE	MM	HC03	S04	CL	NO3	SUM	T.H.	T.A.	SUM	ANI.	ERROR	REFERENCE
Y Y M M D D	Y Y M M D D	N A M E	M		MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	BAL.	
W2 19 18 12-12-NE 800300	BC K3	29.9	7.4	176	98	53	0.5	576	456	4	1364	844	472	19.15	19.05	-0.27	CITY OF REGINA					
W2 19-18-12-12 NE 800600	BC K3	29.9	7.5	165	96	57	0.1	1.52	560	480	6	<1	1366	808	459	18.61	19.34	1.93	AESL, 1981			
W2 19-18 12-12 NE 800600	HC-K3	29.9	7.6	189	95	59	0.2	1.68	569	526	10	<1	1450	856	466	19.81	20.56	1.85	AESL, 1981			
W2 19-18-12-12 NE 830728	BC-K3	29.9	7.4	200	119	63	0.1	1.60	599	570	8	<1	1561	888	466	22.51	21.91	-1.35	CITY OF REGINA			
W2 19-18 12-12-NE 840724	HC K3	29.9	7.4	190	94	57	0.1	1.56	587	472	8	<1	1410	864	481	19.89	19.67	-0.05	CITY OF REGINA			
W2 19-18-12-12-NE 860723	BC K3	29.9	7.3	190	98	59	<0.1	1.50	595	460	10	<1	1414	880	488	20.11	19.61	-1.25	CITY OF REGINA			
NO. SAMPLES	8	8	2	7	6	8	8	8	5	8	8	8	8	8	8	8	8	8	8	8	8	8
MAXIMUM	7.7	200	119	63	0.5	1.68	599	570	10	1561	888	488										
MINIMUM	7.3	160	77	41	0.0	1.20	514	382	4	1192	727	422										
AVERAGE	7.5	179	95	54	0.2	1.51	565	466	7	1369	825	460										
ST. DEV.	0.1	14	12	7	0.2	0.15	31	60	2	116	60	23										
W2 20 17-33-16 NE 800300	W1	49.1	7.5	157	96	95	3.4	1.28	625	492	8	1478	788	512	19.86	20.71	2.09	CITY OF REGINA				
W2-20 17-33-16 NE 800600	W1	49.1	7.1	408	87	101	2.3	1.14	580	484	12	<1	1675	768	475	31.91	19.92	-23.13	AESL, 1981			
W2 20-17 33-16-NE 800700	W1	49.1	7.4	152	113	91	2.0	1.15	588	512	14	1473	844	482	20.84	20.69	-0.35	AESL, 1981				
W2 20-17-33-16-NE 830728	W1	49.1	7.6	178	85	98	1.1	1.28	595	496	14	<1	1468	792	488	20.14	20.47	0.83	CITY OF REGINA			
W2 20 17-33-16 NE 840724	W1	49.1	7.4	165	89	94	2.9	1.20	589	416	14	<1	1371	780	483	19.64	18.71	-2.44	CITY OF REGINA			
W2-20 17-33-16 NE 860723	W1	49.1	7.5	141	104	96	0.9	1.04	600	465	18	<1	1426	780	492	19.77	20.02	0.64	CITY OF REGINA			
NO. SAMPLES	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
MAXIMUM	7.6	408	113	101	3.4	1.28	625	512	18	1675	844	512										
MINIMUM	7.1	141	85	91	0.9	1.04	580	416	8	1371	768	475										
AVERAGE	7.4	200	98	96	2.1	1.18	596	478	13	1482	792	489										
ST. DEV.	0.2	94	10	3	0.9	0.08	14	31	3	94	24	12										
W2 20 17 33 15 NW 660000	W2	46.6	7.4	175	92	91	1.00	661	460	11	1500	813	542	20.26	20.72	1.13	MULLARD, 1966					
W2 20-17 33 15 NW 800300	W2	46.6	7.5	157	99	106	6.3	1.24	627	484	10	<1	1491	800	514	20.59	20.64	0.11	AESL, 1981			
W2 20 17-33-15 NW 800600	W2	46.6	7.2	154	94	118	0.2	1.20	586	512	14	<1	1478	772	480	20.55	20.66	0.26	AESL, 1981			
W2 20 17-33-15 NW 830728	W2	46.6	7.6	173	92	118	1.1	1.24	551	528	12	<1	1476	812	452	21.33	20.36	-2.33	CITY OF REGINA			
W2 20 17 33 15 NW 840724	W2	46.6	7.4	166	98	110	1.5	1.00	599	504	16	<1	1496	820	491	21.13	20.76	0.88	CITY OF REGINA			
NO. SAMPLES	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
MAXIMUM	7.6	175	99	118	6.3	1.24	661	528	16	1605	820	542										

NOTE: THE CA CONCENTRATION OF THE 800600 ANALYSIS IS EITHER A
TYPOGRAPHICAL OR ANALYTICAL ERROR

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE YYMMDD	WELL NAME	DEPTH M	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	HC03 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM IONS MG/L	T.H. MG/L	T.A. SUM MG/L CAT. EPM	SUM ANI. EPM	ERROR BAL. %	REFERENCE
MINIMUM																				
AVERAGE																				
ST. DEV.																				
W2-20-17-32-16-NE 660000		W3	38.1	7.5	171	90	89	9			580	495	7		1441	797	476	19.81	20.01	0.51 MOLLARD, 1966
W2-20-17-32-16-NE 660000		W3	38.1	7.7	163	92	88	9			573	498	8		1435	787	470	19.53	19.99	1.15 MOLLARD, 1966
W2-20-17-32-16-NE 800300		W3	38.1	7.6	160	99	105		2.9	1.00	632	484	10		1495	808	518	20.70	20.72	0.05 CITY OF REGINA
W2-20-17-32-16-NE 800600		W3	38.1	7.3	152	94	111		2.2	1.06	588	528	12	1	1489	766	482	20.15	20.97	2.00 AESL, 1981
W2-20-17-32-16-NE 830728		W3	38.1	7.6	173	92	110		1.1	1.18	606	528	14	<1	1525	812	497	20.99	21.32	0.79 CITY OF REGINA
W2-20-17-32-16-NE 840724		W3	38.1	7.3	173	91	107		1.7	1.00	594	504	16	<1	1488	808	487	20.77	20.68	-0.22 CITY OF REGINA
W2-20-17-32-16-NE 860723		W3	38.1	7.6	163	92	110		0.8	0.92	635	505	20	<1	1527	788	500	20.49	21.49	2.38 CITY OF REGINA
NO. SAMPLES																				
MAXIMUM																				
MINIMUM																				
AVERAGE																				
ST. DEV.																				
W2-20-17-32-15-NW 660000		W4	35.4	7.4	164	87	86	9		0.50	559	468	7		1381	765	458	19.08	19.10	0.06 MOLLARD, 1966
W2-20-17-32-15-NW 800300		W4	35.4	7.6	150	93	86		2.9	1.02	598	424	6		1361	760	490	18.88	18.80	-0.21 CITY OF REGINA
W2-20-17-32-15-NW 800600		W4	35.4	7.2	149	86	95		1.6	1.00	565	448	10	<1	1356	724	463	18.64	18.87	0.61 AESL, 1981
W2-20-17-32-15-NW 840724		W4	35.4	7.3	165	100	86		1.0	0.98	641	472	14	<1	1480	824	525	20.20	20.73	1.29 CITY OF REGINA
W2-20-17-32-15-NW 860723		W4	35.4	7.6	170	83	90		0.8	0.94	627	450	14	<1	1436	764	495	19.23	20.04	2.07 CITY OF REGINA
NO. SAMPLES																				
MAXIMUM																				
MINIMUM																				
AVERAGE																				
ST. DEV.																				
W2 20 18-04 09 NW 860723		W5		7.5	136	85	100		1.2	0.49	592	380	14	<1	1304	668	485	17.72	18.01	0.82 CITY OF REGINA
W2-20 18 12 16 NW 800300		R2	35.4	7.4	161	75	24		0.6	0.82	354	440	26	<1	1101	760	290	16.25	15.70	-1.72 CITY OF REGINA

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE YYMMDD	WELL NAME	DEPTH M	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	HC03 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM IONS MG/L	T.H. MG/L	T.A. MG/L	SUM EPM CAT.	SUM ANI. EPM	ERROR BAL.	REFERENCE
W2-20-18-12-16-NW 800600	R2	35.4	7.2	176	73	25	0.5	1.56	338	462	30	<1	1106	740	277	15.87	16.00	0.41	AESL, 1981		
W2-20-18-12-16-NW 830728	R2	35.4	7.4	210	77	25	0.5	0.86	355	512	60	<1	1240	840	291	17.90	18.17	0.75	CITY OF REGINA		
W2-20-18-12-16-NW 840724	R2	35.4	7.3	206	81	23	0.3	0.88	351	476	64	<1	1202	848	288	17.94	17.47	1.34	CITY OF REGINA		
W2-20-18-12-16-NW 860723	R2	35.4	7.6	237	87	25	<0.1	0.90	371	530	106	<1	1357	952	304	20.07	20.10	0.08	CITY OF REGINA		
NUMBER OF SAMPLES																					
MAXIMUM		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
MINIMUM		7.6	237	87	25	0.6	1.56	371	530	106	1357	952	304								
AVERAGE		7.2	176	73	23	0.0	0.82	338	440	26	1101	740	277								
STAND. DEVIATION		0.1	22	5	1	0.2	0.28	11	33	29	95	75	9								
W2-20-17-24-13-SW 800600	R3	59.4	7.6	144	107	225	1.4	0.42	580	730	26	<1	1814	800	475	25.77	25.44	0.66	AESL, 1981		
W2-20-17-24-13-SW 800600	R3	59.4	7.5	146	96	217	9.0	0.49	581	760	22	<1	1831	760	476	24.32	25.97	2.56	AESL, 1981		
W2-20-17-24-13-SW 830728	R3	59.4	7.6	152	102	216	1.1	0.45	584	730	32	<1	1818	800	479	25.37	25.67	0.59	CITY OF REGINA		
W2-20-17-24-13-SW 840724	R3	59.4	7.8	155	97	213	1.3	0.47	582	690	30	<1	1769	788	477	24.98	24.75	-0.46	CITY OF REGINA		
W2-20-17-24-13-SW 860723	R3	59.4	7.6	147	107	226	2.0	0.39	599	710	34	<1	1825	808	491	25.97	25.56	-0.79	CITY OF REGINA		
NO. SAMPLES																					
MAXIMUM		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
MINIMUM		7.8	155	107	226	9.0	0.49	599	760	34	1831	808	491								
AVERAGE		7.5	144	96	213	1.1	0.39	580	690	22	1769	760	475								
ST. DEV.		7.6	149	102	219	3.0	0.44	585	724	29	1811	791	480								
		0.1	4	5	5	3.0	0.04	7	23	4	22	17	6								
W2-20-17-35-13-NW 800600	R4	40.8	7.1	163	92	94	0.9	1.28	565	484	10	<1	1410	788	463	19.79	19.62	-0.43	AESL, 1981		
W2-20-17-35-13-NW 830728	R4	40.8	7.5	170	92	92	1.0	1.34	582	495	10	<1	1444	804	477	20.05	20.15	0.24	CITY OF REGINA		
PRODUCTION WELL R4 TAKEN OUT OF SERVICE SEPTEMBER 5, 1984																					
W2-19-18-06-01-SE 800600	R5	49.1	7.4	157	87	83	0.1	1.65	547	480	10	<1	1366	752	448	18.60	19.24	1.69	AESL, 1981		
W2-19-18-06-01-SE 830728	R5	49.1	7.4	170	81	87	0.1	1.74	553	468	10	<1	1371	756	453	18.93	19.09	0.42	CITY OF REGINA		
W2-19-18-06-01-SE 840724	R5	49.1	7.5	170	87	80	0.1	1.86	548	432	12	<1	1331	780	449	19.12	18.31	2.15	CITY OF REGINA		
W2-19-18-06-01-SE 860723	R5	49.1	7.4	170	83	87	<0.1	1.40	561	450	14	<1	1366	764	460	19.10	18.96	-0.36	CITY OF REGINA		

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE YYMMDD	WELL NAME	DEPTH M	PH	CA MG/L	MG	NA MG/L	K	FE MG/L	MN MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	SUM IONS MG/L	T.H. MG/L	T.A. MG/L	SUM ANI. EPM	ERROR BAL. %	REFERENCE
NO. SAMPLES																				
MAXIMUM				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
MINIMUM				7.5	170	87	87		0.1	1.86	561	480	14		1371	780	60			
AVERAGE				7.4	157	81	80		0.0	1.40	547	432	10		1331	752	448			
ST.DEV.				7.4	167	85	84		0.1	1.66	552	458	12		1358	763	453			
				0	6	3	3		0	0.17	6	18	2		16	11	5			
NO. SAMPLES																				
MAXIMUM				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
MINIMUM				7.1	152	87	92		0.2	1.44	539	460	14	<1	1346	740	442	18.74	18.81	0.17 AESL, 1981
AVERAGE				7.5	160	87	88		0.1	1.52	544	440	10	<1	1331	756	446	18.97	18.36	-1.63 CITY OF REGINA
ST.DEV.				7.5	152	78	83		0.1	1.56	538	396	12	1	1262	700	441	17.61	17.40	-0.60 CITY OF REGINA
				43	7.5	165	75	86	<0.1	1.12	543	420	14	<1	1304	720	445	18.14	18.04	-0.29 CITY OF REGINA
NO. SAMPLES																				
MAXIMUM				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
MINIMUM				7.5	165	87	92		0.2	1.56	544	460	14		1346	756	446			
AVERAGE				7.1	152	75	83		0.0	1.12	536	396	10		1262	700	441			
ST.DEV.				7.4	157	82	87		0.1	1.41	541	429	12		1311	729	444			
				0.2	6	5	3		0.1	0.17	3	24	2		32	21	2			
NO. SAMPLES																				
MAXIMUM				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
MINIMUM				7.5	142	86	106		0.4	1.56	526	480	14	<1	1356	708	431	18.77	19.01	0.63 AESL, 1981
AVERAGE				7.5	160	87	88		0.1	1.52	544	440	10	<1	1331	756	446	18.97	18.36	-1.63 CITY OF REGINA
ST.DEV.				7.5	147	92	97		0.2	0.98	531	456	18	<1	1342	748	435	19.12	18.70	-1.11 CITY OF REGINA
				31.7	7.5	149	85	102	1.3	0.90	545	450	16	<1	1349	720	447	18.86	18.75	-0.30 CITY OF REGINA
NO. SAMPLES																				
MAXIMUM				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
MINIMUM				7.5	160	92	106		1.3	1.56	545	480	18		1356	756	447			
AVERAGE				7.5	142	85	88		0.1	0.90	526	440	10		1331	708	431			
ST.DEV.				7.5	150	88	98		0.5	1.24	537	457	15		1344	733	440			
				0.0	7	3	7		0.5	0.30	8	15	3		9	20	7			
NO. SAMPLES																				
MAXIMUM				4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
MINIMUM				7.2	136	83	106		0.4	1.20	520	465	14	1	1327	680	426	18.22	18.60	1.02 AESL, 1981
AVERAGE				7.7	160	89	126		0.3	0.72	554	512	20	<1	1462	768	454	20.79	20.30	-1.17 CITY OF REGINA
ST.DEV.				7.6	157	102	134		1.6		573	570	24	<1	1562	812	470	22.05	21.94	-0.27 CITY OF REGINA

TABLE A-2 LIST OF REGINA PRODUCTION WELL WATER QUALITY (CONTINUED)

LAND LOCATION	DATE	WELL	DEPTH	PH	CA	MG	NA	K	FE	MN	HCO3	SO4	CL	NO3	SUM	T.H.	T.A.	SUM	ERROR	REFERENCE
	YYMMDD	NAME	M		MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	IONS	MG/L	MG/L	CAT.	ANI.	BAL.
															MG/L		EPH	EPH		\$
NO. SAMPLES				3	3	3	3	3	2	3	3	3	3	3	3	3	3	3		
MAXIMUM				7.7	160	102	134	1.6	1.20	573	570	24			1562	812	470			
MINIMUM				7.2	136	83	106	0.3	0.72	520	465	14			1327	680	428			
AVERAGE				7.5	151	91	122	0.8	0.96	549	516	19			1450	753	450			
ST. DEV.				0.2	11	8	12	0.6	0.24	22	43	4			96	55	18			

NOTE: THE 800600 ANALYSIS IS TAKEN AS THE SECOND ANALYSIS FOR WELL H6
IN AESL REPORT (1981, TABLE 6)

APPENDIX B
WATER LEVEL DATA

APPENDIX B - WATER LEVEL DATA

Explanation of symbols and abbreviations

1. WELL LOCATION

Municipal land location: Meridian - Range - Township - Section -
(Legal Subdivision) - Quarter.

2. WELL NAME OR NUMBER

Name or number by which well is identified in data source.

3. DATA SOURCE

Source from which the well and water-level data are taken. Where the source is a report this is indicated by author and year, e.g. Beckie (19)77. These reports are listed under References in the main report. Other sources are:

DOE - Saskatchewan Environment Ground Water Data Report.

FFIB - Logs and well data collected under the Family Farm Improvement Branch well assistance program.

SRC - Logs and well data collected by Saskatchewan Research Council staff.

Regina PWED - City of Regina, Public Works and Engineering Department.

SRC Tp File - Miscellaneous well logs held in SRC's Township files.

SRC Records - Water level records collected from SRC's observation well network.

SWC - Logs and well data collected by the Saskatchewan Water Corporation under the Test Drilling Assistance Program.

SWC/IPS - Water level data collected by the Saskatchewan Water Corporation as part of the Instantaneous Piezometric Surface Project.

4. DATUM ELEV METERS

Elevation of datum used; or assumed to have been used, for water level measurements, in meters above mean sea level.

5. DATUM TYPE

Description of datum used:

GRD - ground level

CAS - top of casing

PHF - pump house floor

(Note: When datum type is not given by data source ground level is assumed)

6. CAS HT M

Height of top of casing above ground level (may be negative if well has a pit).

7. DAT ACC

Estimate of reliability of datum elevation

A - within 0.025 meter (accurate survey)

B - within 0.25 meter (approximate survey)

C - within 2.5 meter (estimated from 1:50,000 topographic contours)

8. FM

Formation in which well is completed

CM - Condie Moraine sands and gravels

UF - Upper Floral sands and gravels

IGS - Interglacial sediments

LF - Lower Floral sands and gravels

E - Empress group sands and gravels

9. TOP OF SCREEN METERS

Length in meters to top of screen, from datum.

10. SCREEN BOTTOM METERS

Length in meters to bottom of screen, from datum.

11. STATIC WATER LEVEL METERS

Measured static water level below datum in meters. If datum type is not given in data source, the datum is assumed to be ground level.

Flowing wells are indicated by - 0.00

12. WATER LEVEL ELEVATION METERS

Elevation of static water level in meters above mean sea level.

13. WLV ACC

Estimate of reliability of water-level elevation

A - within 0.025 meters

B - within 0.25 meters

C - within 2.5 meters

Note that water-level accuracy cannot be better than datum accuracy, but may be worse.

14. DATE YYMMDD

Date of water-level measurement - year, month, day

eg. Nov 23, 1983 = 831123

November 1983 = 8311

1983 = 83

15. REMARKS



TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM		CAS HT	DATE ACC	FM	TOP OF		SCREEN BOTTOM	STATIC		WATERLV		DATE	REMARKS
			ELEV METERS	TYPE				SCREEN METERS	METERS		WATERLV METERS	ELEV METERS	WATERLV ACC	WATERLV DATE		
W2-16-16-16-NW	A. EBERLE	FFIB	647.70	GRD	?	C	?	24.08	25.60	9.14	638.56	C	790919			
W2-16-17-06-SE	K. KNOLL	SWC	649.22	GRD	?	C	?	15.24	16.76	3.05	646.17	C	860414			
W2-16-17-12-NW	ROSOM BROTHERS	DOE	676.66	GRD	?	C	?	43.59	45.11	9.45	667.21	C	630815			
W2-16-17-15-SW	H. WESLOWSKI	DOE	670.56	GRD	?	C	?	35.05	36.58	1.83	668.73	C	631101			
W2-16-17-17-SW	R. COPLAND	DOE	662.94	GRD	?	C	?	33.83	35.36	9.14	653.80	C	780816			
W2-16-17-17-SW	W. R. COPLAND	FFIB	665.99	GRD	?	C	?	32.00	33.53	16.76	649.23	C	721012			
W2-16-17-24-SE	G. BECKER	DOE	685.80	GRD	?	C	?	64.92	65.84	18.29	667.51	C	620511			
W2-16-17-28-08-SE	A. KESSEL	FFIB	685.80	GRD	?	C	?	42.67	45.72	16.46	669.34	C	780714			
W2-16-17-28-SW	J. DIEWOLD	DOE	681.23	GRD	?	C	?	36.88	38.10	19.81	661.42	C	690926			
W2-16-17-34-SE	P. LIEBEL	DOE	685.80	GRD	?	C	?	28.96	30.48	18.90	666.90	C	600000			
W2-16-17-35-NE	C. SANSON	DOE	685.80	GRD	?	C	?	28.65	29.57	8.53	677.27	C	620427			
W2-16-17-35-SE	J. BANK	FFIB	682.27	GRD	?	C	?	29.87	31.39	7.62	644.65	C	801102			
W2-16-18-01-NW	M. AD. KECK	SWC	693.42	GRD	?	C	?	56.39	57.91	21.34	672.08	C	870518			
W2-16-18-04-12-SW	L. DUGALO	SWC	691.90	GRD	?	C	?	58.44	60.96	22.86	669.04	C	870418			
W2-16-18-05-SE	R. KESSEL	DOE	690.37	GRD	?	C	?	24.38	27.13	18.93	671.44	C	600000			
W2-16-18-08-NW	G. EBENAL	DOE	693.42	GRD	?	C	?	44.20	45.72	12.19	681.23	C	720927			
W2-16-18-09-02-SW	M. MELYNCHUK	SWC	693.42	GRD	?	C	?	31.09	32.61	14.02	679.40	C	870423			
W2-16-18-09-12-NW	M. OLSON	SWC	693.42	GRD	?	C	?	41.45	44.50	27.43	665.99	C	860610			
W2-16-18-09-SE	L. GETZ	DOE	693.42	GRD	?	C	?	32.61	34.14	22.56	670.86	C	720514			
W2-16-18-10-06-SE	G. FORESTER	FFIB	699.52	GRD	?	C	?	37.49	39.01	22.86	676.66	C	830330			
W2-16-18-10-16-SE	G. FORRESTER	FFIB	697.99	GRD	?	C	?	37.49	39.01	22.86	675.13	C	830328			
W2-16-18-11-SW	MCLEAN CAMPSITE	DOE	693.72	GRD	?	C	?	76.20	79.25	27.13	666.59	C	810881			
W2-16-18-11-SW	MCLEAN PARKWELL	DOE	691.00	GRD	?	C	?	77.11	79.25	24.99	666.91	C	621017			
W2-16-18-13-SE	J. ASHWORTH	DOE	693.42	GRD	?	C	?	?	?	25.91	687.51	C	460912	OPEN HOLE		
W2-16-18-13-SE	MCLEAN	DOE	699.21	GRD	?	C	?	74.68	79.25	27.74	671.47	C	700000	OPEN HOLE		
W2-16-18-17-NE	E. WAGNER	DOE	697.99	GRD	?	C	?	?	?	26.82	671.17	C	460504			
W2-16-18-17-NW	M. WAGNER	DOE	701.04	GRD	?	C	?	72.85	74.37	54.86	646.18	C	810605			
W2-16-18-18	G. BECKER	DOE	696.47	GRD	?	C	?	66.45	67.67	18.29	678.18	C	790927			
W2-16-18-19-08-NE	P. VAKYMYK	FFIB	701.04	GRD	?	C	?	50.29	51.82	17.37	683.67	C	800915			
W2-16-18-19-14-NE	K. DONNELLY	FFIB	696.47	GRD	?	C	?	34.14	35.66	13.72	682.75	C	790927			
W2-16-18-20-04	T. BECKETT	FFIB	701.04	GRD	?	C	?	42.67	44.20	17.98	683.06	C	790926			
W2-16-18-28-05-NW	G. ECKSTEIN	FFIB	693.42	GRD	?	C	?	46.63	48.16	24.69	668.73	C	770829			
W2-16-18-28-09-NE	R. LONG	SWC	701.04	GRD	0.61	C	?	56.38	57.91	22.86	678.18	C	870520			
W2-16-18-29-SE	J. MCUNN	DOE	701.04	GRD	?	C	?	39.01	42.67	23.77	677.27	C	800701			
W2-16-18-32-01-NE	M. GILLERT	FFIB	701.04	GRD	?	C	?	114.91	117.06	87.48	613.56	C	810721			
W2-16-18-33-SE	R. GALENZOSKI	DOE	701.04	GRD	?	C	?	77.72	79.51	19.51	681.53	C	760709			
W2-16-19-04-SW	R. LINDENBACH	DOE	701.04	GRD	?	C	?	56.69	58.22	22.86	678.18	C	731001			
W2-16-19-05-06-NW	P. R. LINDENBACH	SWC	694.94	GRD	?	C	?	60.96	62.48	25.60	669.34	C	860403			

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT FM ACC	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WMLV DATE ACC YMMDD	REMARKS
W2-16-19-08-14-SW	G.LINDENBACK	PFIB	676.66	GRD	?	C	?	58.83	60.35	14.94	661.72 C	740000
W2-16-19-20-15-NE	K.SCHULZ	PFIB	665.99	GRD	?	C	?	79.55	81.08	18.29	647.70 C	791004
W2-16-19-31-11-SE	E.KOCH	PFIB	649.22	GRD	?	C	?	74.98	76.50	16.76	649.22 C	800506
W2-16-19-31-NW	P.KOCH	DOE	650.75	GRD	?	C	?			15.85	634.90 C	320610
W2-16-20-05-13-NW	R.KRAMER	PFIB	640.08	GRD	?	C	?	60.66	62.18	32.00	608.08 C	800331
W2-16-20-14-NE	P.WALTERS	SMC	618.74	GRD	?	C	?	32.00	33.53	6.10	612.64 C	870501
W2-16-20-16-08-SW	D.FROMBACH	PFIB	624.84	GRD	?	C	?	46.33	49.38	18.29	606.55 C	770711
W2-17-16-34-08-NW	F.SCHOENRATH	SMC	609.60	GRD	?	C	?			3.05	606.55 C	851017
W2-17-17-19-13	D.A.A.B.	SMC	617.22	GRD	?	C	CM	4.88	6.40	4.57	612.65 C	700400
W2-17-17-29-05-NW	E.THOMAS	SMC	667.51	GRD	?	C	?	28.35	29.87	12.19	612.65 C	851018
W2-17-18-03-03-SW	W.MELNYCHUK	SMC	667.51	GRD	?	C	?	28.96	30.48	9.14	658.37 C	860418
W2-17-18-04-NE	BALGONIE TEST WELL	STOCK 63	664.46	GRD	?	C	UP	27.13	30.18	19.05	645.41 C	630309
W2-17-18-04-NE	OBS WELL.	SASK ENV. 70	664.46	GRD	?	C	?	?	?	22.70	641.69 C	700610
W2-17-18-04-NE	WELL #2	SASK ENV. 70	664.46	GRD	?	C	?	?	?	23.23	641.24 C	700610
W2-17-18-07-16-NE	BALGONIE OBS 1-75	MOLLARD 75	655.00	CAS	0.46 A	UP		33.62	35.36	18.18	636.52 A	750603
W2-17-18-07-16-NE	BALGONIE OBS 1-75	SMC/IPS	655.00	CAS	0.39 A					18.69	636.32 A	870305
W2-17-18-07-16-NE	BALGONIE OBS 1-75									18.81	636.19 A	870414
W2-17-18-07-16-NE	BALGONIE OBS 1-75									19.17	635.83 A	870812
W2-17-18-10-05-SE	A.STIEFEL	SMC	670.56	GRD	?	C	UP	38.40	39.93	26.21	644.35 C	871123
W2-17-18-16-02-SW	G.GRAY	PFIB	667.51	GRD	?	C	UP		38.10	21.34	646.17 C	861114
W2-17-18-22-14-NE	T.HUBER	PFIB	678.18	GRD	?	C	LF	65.84	68.88	44.50	633.68 C	760719
W2-17-18-28-13-NW	H.MACHNER	SMC	685.80	GRD	?	C	?	39.82	41.15	21.34	664.46 C	781030
W2-17-18-31-08-SE	E.KOCH	SMC	676.66	GRD	?	C	UP	45.72	47.24	28.35	648.31 C	860521
W2-17-18-31-11-NW	W.HUBICK	SMC	678.18	GRD	?	C	UP	42.67	44.20	28.96	649.22 C	840911
W2-17-19-02-12-SW	M.SCHREINER	PFIB	693.42	GRD	?	C	?	75.29	78.33	25.91	667.51 C	820803
W2-17-19-03-01-SE	E.STEWART	SMC	685.80	GRD	?	C	?	23.47	24.99	11.28	674.52 C	810428
W2-17-19-04-03-NE	J.MANG	SMC	676.77	GRD	?	C	?	85.34	88.30	0.61	676.05 C	870707
W2-17-19-14-15-NW	W.H.REICHEL	SRC	673.61	GRD	?	C	LF	105.77	108.81	15.24	658.37 C	830610
W2-17-19-22-09-SE	G.SEIGA	SMC	670.56	GRD	?	C	?	80.77	82.30	9.14	661.42 C	730800
W2-17-19-24-12-NW	M.KOCH	PFIB	676.66	GRD	?	C	?	106.88	108.20	8.53	668.13 C	870504
W2-17-20-12-02-NW	K.MANG	SMC	633.98	GRD	?	C	?	58.83	60.35	28.96	605.02 C	830215
W2-17-21-12-SE	W.LUEYK	DOE	594.36	GRD	?	C	?	74.07	77.11	12.19	582.17 C	840917
W2-18-17-10-SW	G.BROCK	DOE	586.74	GRD	?	C	?	12.88	15.24	11.58	575.16 C	811114
W2-18-17-18-SW	WATT	WYNN ROB 12	583.69	GRD	?	C	?	?	36.58	0.00	583.69 C	790913
W2-18-17-20-SE	BUFFALO LOOKOUT	DOE	594.36	GRD	?	C	?	22.86	25.91	16.15	578.21 C	120000
W2-18-17-21-13-NW	R.ELKLO	SRC	603.50	GRD	?	C	?	12.19	15.24	5.49	598.02 C	670525
W2-18-17-23-02-SW	C.WOLOSHYN	SMC	609.60	GRD	?	C	CM	36.58	38.10	21.34	588.26 C	700716
W2-18-17-23-07-SW	B.BRENNAN	SMC	609.60	GRD	?	C	?	19.81	21.34	6.71	602.89 C	870511
												870810

CORRECT STATIC?

SCREEN ALSO 28.96 34.75
FLOWING WELL.

PERF PLASTIC CASING
SWL FROM E LOG

OPEN HOLE

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	ACC	PM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	MLV DATE ACC YMMDD	REMARKS
W2-18-17-24-09-SE	R. SCHNEIDER	SWC	615.70 GRD	?	C	CM		6.10	7.62	3.05	612.65 C	861130	
W2-18-17-24-SW	DADS COOKIES	DOE	609.60 GRD	?	C	?		23.77	25.30	2.74	606.86 C	850800	
W2-18-17-25-05	CS1	SWC/IPS	616.39 CAS	0.29	A	CM			6.32	2.60	613.79 A	870305	
W2-18-17-25-05	CS1									2.45	613.94 A	870414	
W2-18-17-25-05	CS1									2.47	613.92 A	870812	
W2-18-17-25-05	CS1									2.66	613.73 A	871123	
W2-18-17-25-05	CS2	SWC/IPS	616.03 CAS	0.52	A	CM			5.47	2.20	613.83 A	870305	
W2-18-17-25-05	CS2									2.20	613.83 A	870414	
W2-18-17-25-05	CS2									2.26	613.77 A	870812	
W2-18-17-25-05	CS2									2.41	613.62 A	871123	
W2-18-17-26-05 NW	OBS WELL #2	BECKIE 77	617.22 GRD	0.15	C	CM		8.69	9.14	2.38	614.84 C	770300	
W2-18-17-29-12 NW	OBS E85-3	BECKIE 85	600.30 CAS	0.80	A	UP		39.81	40.72	13.10	587.20 C	850328	
W2-18-17-29-12 NW	OBS E85-3	SWC/IPS								10.72	589.58 A	870305	
W2-18-17-29-12 NW	OBS E85-3									10.21	590.09 A	870414	
W2-18-17-29-12 NW	OBS E85-3									20.48	579.82 A	870812	
W2-18-17-29-12 NW	OBS E85-3									11.02	589.28 A	871123	
W2-18-17-29-13	OBS E85-1	BECKIE 85	598.00 CAS	?	C	UP		54.24	55.15	12.08	586.92 C	850328	
W2-18-17-30-02 SW	LADYRAND ENT. LTD.	PFIB	594.36 GRD	?	C	UP		42.67	45.72	15.24	579.12 C	790625	
W2-18-17-30-13-NW	H.ZINKHAM	PFIB	594.36 GRD	?	C	UP		50.29	51.82	7.32	587.04 C	730600	
W2-18-17-30-SE	EMBURY #1	HILL 30	594.36 GRD	?	C	UP		24.38	38.10	0.30	594.06 C	281000	
W2-18-17-30-SE	EMBURY #2	HILL 30	594.36 GRD	?	C	UP		39.32	46.02	-0.61	594.97 C	281000	
W2-18-17-31-NE	CITY OF REGINA #6	DOE	605.03 GRD	?	C	CM		18.29	19.61	13.11	591.92 C	610816	
W2-18-17-31-NW	CITY OF REGINA #5	DOE	601.98 GRD	?	C	UP		46.94	48.46	4.98	597.10 C	610816	
W2-18-17-32-08 NW	OBS 6-84	BECKIE 84	608.43 CAS	1.24	A	CM		15.48	16.09	7.47	600.96 A	840504	
W2-18-17-32-08 NW	OBS 6-84	SWC/IPS								6.17	602.26 A	870408	
W2-18-17-32-08 NW	OBS 6-84									6.16	602.27 A	870414	
W2-18-17-32-08 NW	OBS 6-84									6.23	602.20 A	870812	
W2-18-17-32-08 NW	OBS 6-84									6.18	602.25 A	871123	
W2-18-17-33-07 NE	CRAWFORD HOMES	SWC	618.74 GRD	?	C	CM		18.90	20.42	7.92	610.82 C	861206	
W2-18-17-33-07 NE	K.WOITAS	SWC	618.74 GRD	?	C	UP?		16.76	18.29	0.91	617.83 C	870731	
W2-18-17-33-07 NE	L.LOLACHER	SWC	618.74 GRD	?	C	CM		14.33	15.85	7.62	611.12 C	870717	
W2-18-17-33-07 NW	UNITED CHURCH	SWC	618.74 GRD	?	C	CM		16.76	18.29	9.14	609.60 C	870627	
W2-18-17-33-09 SE	OBS 4-84	SWC/IPS	617.27 CAS	0.67	A	CM		16.62	17.43	7.39	609.88 A	870331	
W2-18-17-33-09 SE	OBS 4-84									7.49	609.78 A	870812	
W2-18-17-33-09 SE	OBS 4-84									7.54	609.73 A	871123	
W2-18-17-33-09 SE	OBS 4-84									8.23	607.47 C	861024	
W2-18-17-33-10 NE	K.JOHNSON	SWC	615.70 GRD	?	C	CM		18.90	20.42	8.23	607.47 C	861024	
W2-18-17-33-10 NE	D.HARRISON	SWC	620.27 GRD	?	C	CM		15.54	17.07	10.97	609.30 C	870713	
W2-18-17-33-10 NE	E.ZOMBER	SWC	618.74 GRD	?	C	CM		19.81	21.34	11.28	607.46 C	870608	
W2-18-17-33-10 SE	D.LOZINSKY	SWC	617.22 GRD	?	C	CM		17.68	19.20	6.10	611.12 C	860716	

PROTECTIVE CASING 599.66

SEE P. 96 REPORT
LISTED WELL
ABANDONED

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT	DAT ACC	FM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLY ELEV METERS	WATERLY ELEV ACC	DATE	REMARKS
W2 18 17-33-10 SE	N. PAETSCH	SMC	618.74 GRD	?	C	CM		18.90	20.42	8.53	610.21 C	870113	
W2 18 17-33-10 SW	F. OBELMAN	SMC	612.65 GRD	?	C	CM		12.19	13.72	4.57	608.08 C	860518	
W2 18 17-33-15 NW	B. PETERS	SMC	618.74 GRD	?	C	CM		19.81	21.34	11.28	607.46 C	870610	
W2 18 17-33-15 NW	SOLIE DRILLING	SRC	620.27 GRD	?	C	CM		?	?	10.67	609.60 C	740603	
W2 18 17-33-16 NE	E. BUSKOW	SMC	615.70 GRD	?	C	CM		10.36	11.89	4.88	610.82 C	860703	
W2 18 17-33-16 NE	I. WEGMANN	SMC	618.74 GRD	?	C	CM		12.19	13.72	6.10	612.64 C	870703	
W2 18 17-33-16 NW	OBS 5-84	BECKIE 84	618.88 CAS	0.93	A	CM		14.34	14.95	8.91	609.97 A	840503	
W2 18 17-33-16 NW	OBS 5-84	SMC/IPS								8.69	610.19 A	870331	
W2 18 17-33-16 NW	OBS 5-84									8.68	610.20 A	870414	
W2 18 17-33-16 NW	OBS 5-84									8.82	610.06 A	870812	
W2 18 17-33-16 NW	OBS 5-84									8.79	610.09 A	871123	
W2 18 17-35-04 NW	#2 TRIAL WELL	BECKIE 77	617.22 GRD		0.46	C	?	18.59	21.64	2.44	614.78 C	770300	
W2 18 17-35-04 NW	OBS WELL #5	BECKIE 77	617.22 GRD		0.46	C	CM	8.69	9.14	2.44	614.78 C	770300	
W2 18 17-35-14 NE	B. PUTZ	SMC	624.84 GRD	?	C	?	?	34.75	36.27	7.62	617.22 C	840617	
W2 18 17-36-13 NW	C. HARDEN	SMC	626.36 GRD	?	C	?	?	46.77	50.29	15.24	611.12 C	850829	
W2 18 18-03 SE	PRAIRIE FEEDERS	DOE	617.22 GRD	?	C	?	?	24.99	28.04	3.05	614.17 C	690526	
W2 18 18-03 SE	R. KOLB	DOE	617.22 GRD	?	C	?	?	26.82	28.35	9.14	608.08 C	710929	
W2 18 18-04-05 NW	SMC REGINA 2	SMC/BECKIE 87	620.59 CAS	0.18	A	UP		37.95	39.62	8.47	612.12 B	871210	
W2 18 18 04-05 NW	SMC REGINA 3	SMC/BECKIE 87	620.70 CAS	0.14	A	CM		14.32	16.00	12.61	608.09 B	871210	
W2 18 18 06 SE	CITY OF REGINA #12	DOE	609.60 GRD	?	C	?	?	31.70	33.22	12.19	597.41 C	610823	
W2 18 18-07-02 SW	D1-86	BECKIE 1986	611.87 CAS	0.91	A	?	?	38.71	39.50	15.41	596.46 A	860331	
W2 18 18-07-02 SW	D1-86	SMC/IPS								16.14	595.73 A	870414	
W2 18 18 07-02 SW	D1-86									20.79	591.09 A	870812	
W2 18 18 07-02 SW	D1-86									15.14	596.73 A	871123	
W2 18 18-07-02 SW	TH6-85	SMC/IPS	607.62 CAS	0.53	A	CM?	?	?	13.17	4.16	603.46 A	870414	
W2 18 18 07-02 SW	TH6-85									5.01	602.61 A	870812	
W2 18 18 07-02 SW	TH6-85									4.98	602.64 A	871123	
W2 18 18 07-04 NW	D5	BECKIE 1986	609.82 CAS	0.84	A	?		60.96	61.88	15.27	594.55 A	860404	
W2 18 18 07-05 SW	OBS WELL #1	AESL 77	602.14 CAS	?	A	CM		12.80	13.72	1.93	600.21 A	770613	
W2 18 18 07-06 SE	S8-86	BECKIE 1986	610.46 CAS	0.99	A	CM?		15.32	16.23	10.26	600.20 A	860409	
W2 18 18 07 06 SE	S8-86	SMC/IPS								10.86	599.58 A	870414	
W2 18 18 07 06 SE	S8-86									10.97	599.49 A	870812	
W2 18 18 07 06 SE	S8-86									10.89	599.57 A	871123	
W2 18 18 07 07 NE	TH1-85	SMC/IPS	616.12 CAS	0.78	A	CM?	?	?	17.57	14.54	601.58 A	870414	
W2 18 18 07 07 NE	TH1-85									14.70	601.43 A	870812	
W2 18 18 07 07 NE	TH1-85									14.55	601.57 A	871123	
W2 18 18 07 07 NW	REG. BCW7	BECKIE 1986	609.07 GRD	?	A	?		34.04	60.83	14.42	594.65 A	860400	
W2 18 18 07 07 NW	D4-86	BECKIE 1986	609.80 GRD	?	A	?		41.00	55.63	13.19	596.41 A	860403	
W2 18 18 07 07 NW	D4-86	SMC/IPS								16.85	592.75 A	870414	

SCREEN + 5CM BELOW TOC
SCREEN + 5CM BELOW TOCSCR 34.0 40.3 45.2 60.8
SCR 41.0 41.9 54.7 55.6

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	PM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV' METERS	WATERLV ELEV METERS	WATERLV ACC YVMD	DATE	REMARKS	
W2 18-18-07-07 NW	D4-86								23.63	585.97	A	870812		
W2 18-18-07-07 NW	D4 86								14.96	594.64	A	871123		
W2 18-18-07-09 NE	REG. BC6	MLM 82	617.22	GRD	0.34	A	?	62.46	68.58				DRILLED	
W2 18-18-07-15 NE	REG. BC 5	REGINA PWED	605.79	GRD	?	B	?	45.11	57.91	10.15	595.64	B	770426	
W2 18-18-07-15 NE	REG. BC 5	MLM 80	605.79	PHF	?	B	?	46.11	57.91	11.58	594.21	B	800000	
W2 18-18-07-15 NE	HOYS SCOUT ASSOC.	DOE	609.60	GRD	?	C	?	23.77	29.87	12.19	597.41	C	540621	
W2 18-18-07-15 NE	REG. P 60	LISSEY 62	605.73	GRD	0.13	B	?	51.82	57.91	7.80	597.93	B	610114	
W2 18-18-07-15 NE	REG. P 60	LISSEY 62	605.73	GRD	0.13	B	?	51.82	57.91	7.77	597.96	C	600630	
W2 18-18-07-15 NE	TH 81 2	MLM 82	618.53	CAS	0.70	A	?	65.53	68.58	22.11	596.42	A	820511	
W2 18-18-07-15 NE	TH 81 2	MLM 82	618.53	GRD	0.70	A	?	65.53	68.58	25.69	592.84	A	811116	
W2 18-18-07-15 NE	CITY OF REGINA	DOE	601.98	GRD	?	C	?	33.53	35.05	3.96	598.02	C	610912	
W2 18-18-08-12 NE	OBS WELL #5	AESL 77	612.42	CAS	?	A	CM	12.88	13.72	6.40	606.02	A	770613	
W2 18-18-08-12 NE	J.W. ZALUSKY	DOE	617.22	GRD	?	C	UP	17.68	18.90	14.02	603.20	C	650512	
W2 18-18-08-12 NE	ZALUSKY SAND&GRAVEL	DOE	620.27	GRD	?	C	CM	17.98	19.51	13.41	606.86	C	680925	
W2 18-18-08-12 NE	OBS. 6	BECKIE 77	629.56	CAS	0.46	C	LP	22.86	23.62	7.48	622.07	C	770518	
W2 18-18-10-16 NE	CITY OF REGINA	DOE	632.46	GRD	?	C	LP	26.82	28.65	24.08	608.38	C	610914	
W2 18-18-12 NW	HWY1-76	SNC/IPS	649.40	CAS	1.05	A	UP		19.07	DRY	DRY	A	870408	
W2 18-18-13-01 SE	HWY1-76								19.05	630.35	A	871123		
W2 18-18-13-01 SE	HWY1-76								5.49	626.97	C	770512		
W2 18-18-13-01 SE	HWY1-76								24.36	608.08	C	850716		
W2 18-18-14 SW	PASQUA PAVING	DOE	632.46	GRD	?	C	LP	35.97	37.49	27.43	597.41	C	721023	
W2 18-18-16 SE	E.LIERFL	SNC	624.84	GRD	?	C	?	42.98	44.50	36.27	591.62	C	760209	
W2 18-18-16 SE	J.KUPFNER	DOE	627.89	GRD	?	C	LP	50.29	51.82	39.01	601.07	C	860409	
W2 18-18-20-01 SW	P.BORSCHNECK	SNC	640.08	GRD	?	C	LP	51.82	53.34	34.14	605.94	C	790917	
W2 18-18-20-16 NW	D. GRAHAM	SNC	640.08	GRD	?	C	LP	62.18	65.23	39.01	601.07	C	650800	
W2 18-18-21-13 NW	POSHEN & WEISBROD	PFIB	640.08	GRD	?	C	LP	52.12	53.64	27.43	612.65	C	731219	
W2 18-18-21-14 NE	R. BRODT	DOE	640.08	GRD	?	C	LP	52.43	53.95	39.62	601.98	C	850825	
W2 18-18-21-14 NE	R. BRODT	SNC	641.60	GRD	?	C	?	50.60	52.12	27.43	612.65	C	731219	
W2 18-18-22 NW	G.GOTTSELIG	DOE	640.08	GRD	?	C	LP	47.24	48.77	36.58	603.50	C	860715	
W2 18-18-22-14 SE	G.GOTTSELIG	SNC	640.08	GRD	?	C	LP	28.35	29.87	14.63	625.45	C	630123	
W2 18-18-22 SE	A.WOLF	DOE	640.08	GRD	?	C	S	84.12	85.65	39.62	600.46	C	840509	
W2 18-18-23 06 NE	J.C.MEIER	SNC	646.41	CAS	0.81	A	UP		25.07	24.07	622.34	A	870408	
W2 18-18-24 04 SW	HWY5-76								24.09	622.32	A	870414		
W2 18-18-24 04 SW	HWY5 76								24.12	622.29	A	870812		
W2 18-18-24 04 SW	HWY5-76								24.10	622.31	A	871123		
W2 18-18-24 04 SW	HWY5 76								20.73	634.59	C	840823		
W2 18-18-24 10 NE	I. CRUSON	SNC	655.32	GRD	?	C	UP	32.00	33.53	41.76	607.46	C	850306	
W2 18-18-24 14 SW	T.WARD	SNC	649.22	GRD	?	C	LP	58.22	59.74	42.06	608.69	C	711207	
W2 18-18-24-14 SW	T.WARD	SNC	650.75	GRD	?	C	LP	58.22	59.74					

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	PM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WATERLV WLV DATE ACC YVMDDI	REMARKS
W2 18 18 24-16 NE	I. CRUSON	SMC	655.32 GRD	?	C	LP	60.96	62.48	36.58	618.74 C		
W2 18 18 25 13 NW	J. MOHR	SMC	661.42 GRD	0.61 C	LP	LP	67.67	69.19	51.21	610.21 C	851027	
W2 18 18 27 01 SW	D. CANTELON	SMC	646.18 GRD	?	C	LP	42.67	44.20	33.53	612.65 C	850423	
W2 18 18 29 SE	D. GLEN	SMC	640.08 GRD	?	C	LP	54.56	56.08	39.62	600.46 C	850809	
W2 18 18 31-04 SE	H. JOWSEY	SMC	624.84 GRD	?	C	?	45.11	46.63	28.65	596.19 C	870121	
W2 18 18 32-14 NW	D. MAKAY	SMC	646.18 GRD	?	C	LP	59.44	60.96	33.53	612.65 C	730700	
W2 18 18 32-14 NW	M. KOJINZ	SMC	646.18 GRD	0.91 C	LP	LP	60.05	61.57	54.86	591.32 C	861012	
W2 18 18 32 NW	R. HOFFMAN	DOE	644.96 GRD	?	C	LP	53.64	57.00	48.77	596.19 C	851023	
W2 18 18 33 15 NW	R. HOFFMAN	DOE	647.70 GRD	?	C	LP	64.01	65.53	47.24	600.46 C	780918	
W2 18 18 34 13 SW	J. FRITZ	PFIB	658.37 GRD	?	C	LP	64.01	65.53	48.16	610.21 C	680930	
W2 18 18 36	B. GORDEN	PFIB	655.32 GRD	?	C	LP	62.48	64.01	46.64	608.68 C	770720	
W2 18 19 01-03 SW	GOV'T WELL	WYNNE ROB 12	670.56 GRD	?	C	?	?	61.57	32.61	637.95 C	810621	
W2 18 19-03 SE	W.B. THOMPSON	PFIB	673.61 GRD	?	C	LP	66.75	68.28	59.44	614.17 C	770400	
W2 18 19-09 08 NE	J. KNUBBEN	PFIB	661.42 GRD	?	C	LP	57.91	59.44	49.68	611.74 C	811009	
W2 18 19-10 09 NE	K. SAUER	SMC	673.61 GRD	?	C	LP	60.05	61.57	45.11	628.50 C	820817	
W2 18 19 22 13 SE	M. NEMETH	SMC	679.70 GRD	?	C	LP	88.39	89.82	73.15	806.55 C	870328	
W2 18 19 29 08 NE	SEITZ BROS. DAIRY	SRC	673.61 GRD	?	C	UP	54.86	56.39	54.25	619.35 C	700324	
W2 18 19 34 15 NE	J. WSZALEK	PFIB	664.46 GRD	?	C	UP	57.91	59.44	52.73	611.73 C	810312	
W2 18 20-10 16	J. WSZALEK	PFIB	676.66 GRD	?	C	?	86.26	87.78	71.63	605.03 C	810325	
W2 18 20 28 03 SE	A. LAVALLEE	SMC	667.51 GRD	?	C	LP	79.25	82.30	-3.05	670.56 C	840827	
W2 19 16-21	GERMAN COLONY	WYNNE ROB 12	658.37 GRD	?	C	LP	76.20	79.25	48.77	609.60 C	820824	
W2 19 16 33 NW	THIO BR60	LISSEY 62	575.00 GRD	?	C	?	?	12.80	0.00	575.00 C	120000	FLOWING WELL
W2 19 16 34 13 NW	J. P. HUGILL	PFIB	573.54 GRD	2.97 B	UP	UP	6.71	16.76	-2.51	576.05 B	601102	FLOWING WELL
W2 19 16 35 04 SW	ORIS WELL 1	PFIB	575.00 GRD	?	C	UP	18.59	20.12	-1.52	575.00 C	730600	FLOWING WELL
W2 19 17 01 02 NW	P. SCHNEIDER	MOLLARD 68	579.12 CAS	0.43 C	UP	UP	25.88	26.49	2.58	576.54 C	680702	
W2 19 17 01 13 NW	T. CURRAN	SRC	575.00 GRD	?	C	UP	28.96	30.46	1.52	573.48 C	710500	
W2 19 17 01 NW	L. ROGER	DOE/SRC	576.07 GRD	?	C	UP	15.54	17.07	3.35	572.72 C	690826	
W2 19 17 01 03 SW	F. SCHNEIDER	DOE/SRC	576.07 GRD	?	C	UP	18.98	20.42	3.05	573.02 C	710917	
W2 19 17 02 SE	F. SCHNEIDER	DOE	576.07 GRD	?	C	UP	23.47	24.99	0.30	575.77 C	690600	
W2 19 17 19	EMMIGRATION HALL	DOE	575.00 GRD	?	C	UP	21.34	22.88	3.66	571.34 C	790924	
W2 19 17 19 12 SE	VICTORIA PARK	WYNNE ROB 12	576.07 GRD	?	C	UP	?	?	7.62	568.45 C	120000	
W2 19 17 19 12 SE	VICTORIA PARK	SWC/IPS	576.77 CAS	-0.04 A	?	?	?	55.02	18.95	557.82 A	870403	
W2 19 17 19 12 SE	VICTORIA PARK								18.93	557.84 A	870414	
W2 19 17 19 12 SE	VICTORIA PARK								19.31	557.47 A	870812	
W2 19 17 19 14 SE	VICTORIA PARK								19.05	557.72 A	871123	
W2 18 17 19 NW	FIRST CITY WELL	SASK ARCHIVES	577.00 GRD	?	C	IGS	?	29.57	9.14	567.86 C	830424	REGINA LEADER 1883/04/26
W2 19 17 19 NW	CITY OF REGINA	DOE	579.12 GRD	?	C	IGS	?	?	19.35	559.77 C	491000	OPEN HOLE
W2 19 17 19 NW	PALM DAIRY	DOE	579.12 GRD	?	C	IGS	56.69	59.74	16.76	562.36 C	550222	
W2 19 17 19 NW	SILVERWOOD DAIRY	DOE	579.12 GRD	?	C	IGS	54.86	57.88	19.20	559.92 C	640900	

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV ELEV METERS	WATERLV ELEV METERS	MLV DATE ACC YVMDH	REMARKS	
W2-19-17-19-NW	VICTORIA PARK PD#1	LISSEY 62	576.07 GRD	?	?	C	IGS	?	54.25	19.35	556.72 C	620309	DRILLED APR/50
W2-19-17-19-SE	SICKS BREWERY	DOE	573.02 GRD	?	?	C	IGS	22.25	25.91	15.24	557.78 C	500117	
W2-19-17-19-SE	SICKS BREWERY	DOE	576.07 GRD	?	?	C	IGS	63.70	67.06	15.65	560.22 C	500301	
W2-19-17-24-10-SW	B. WEBB	SWC	565.22 GRD	?	?	C	?	13.11	14.63	9.14	576.08 C	820428	
W2-19-17-24-09-SE	K. MILLER	DOE	566.74 GRD	?	?	C	E	77.42	75.94	4.88	581.86 C	681200	
W2-19-17-24-NW	W.T. COWLEY	DOE	566.74 GRD	?	?	C	CM	13.72	15.24	11.28	575.46 C	560705	
W2-19-17-24-SE	G. LITOWSKI	DOE	566.74 GRD	?	?	C	CM	?	10.36	6.10	580.64 C	700416	
W2-19-17-24-SE	J. OXMAN	DOE	566.74 GRD	?	?	C	CM	9.14	10.67	6.10	580.64 C	650723	
W2-19-17-25-12-NW	REG. K1	LISSEY 62/DOE	565.20 CAS	?	?	A	UP	31.39	42.37	2.74	582.45 B	290000	
W2-19-17-25-12-NW	REG. K1	HILL 30	565.20 CAS	?	?	A	UP	31.39	42.37	4.27	580.63 B	290000	
W2-19-17-25-12-NW	REG. K1	MOLLARD 67	565.20 PHF	?	?	A	UP	31.39	42.37	4.97	580.22 A	670309	
W2-19-17-25-12-NW	REG. K1	REGINA PWED	565.20 CAS	?	?	A	UP	31.39	42.37	0.00	585.00 B	850124	WELL FLOWING
W2-19-17-25-12-NW	REG. K2	DOE	566.50 CAS	?	?	A	UP	30.78	42.37	3.66	582.84 B	290000	DRILLED
W2-19-17-25-12-NW	REG. K2	MOLLARD 67	566.50 PHF	?	?	A	UP	30.78	42.37	6.29	580.21 A	670309	
W2-19-17-25-12-NW	REG. P1	MOLLARD 67	565.40 GRD	?	0.46	A	UP	31.09	42.67	5.04	580.35 A	670308	
W2-19-17-25-12-NW	REG. P1	REGINA PWED	565.52 GRD	?	?	B	UP	29.87	42.67	0.00	585.52 C	851011	DRILLED
W2-19-17-30-02-NE	SASK CO OP CREAMERY	DOE	579.12 GRD	?	?	C	IGS	59.44	64.01	21.34	557.78 C	670920	WELL FLOWING
W2-19-17-30-02-NE	DAIRY PRODUCER'S #1	SWC/ISP	576.44 CAS	?	0.24	A	IGS		62.05	18.70	557.74 A	870403	
W2-19-17-30-02-NE	DAIRY PRODUCER'S #1									18.68	557.76 A	870414	
W2-19-17-30-02-NE	DAIRY PRODUCER'S #1									19.17	557.27 A	870812	
W2-19-17-30-02-NE	DAIRY PRODUCER'S #1									18.73	557.71 A	871123	
W2-19-17-30-03	LEADER PUBL.	HILL 30	574.55 GRD	?	?	C	IGS	?	39.62	12.50	582.05 C	290000	SEE P. 24
W2-19-17-30-03	McCALLUM HILL	HILL 30	574.55 GRD	?	?	C	IGS	?	60.05	12.80	581.75 C	290000	SEE P. 24
W2-19-17-30-03	McCALLUM HILL	HILL 30	574.55 GRD	?	?	C	IGS	?	60.05	13.72	580.83 C	290000	SEE P. 24
W2-19-17-30-04	ADANAC BREWERY	HILL 30	574.55 GRD	?	?	C	IGS	?	59.44	12.19	582.36 C	290000	SEE P. 24
W2-19-17-30-06-NE	SIMPSON'S SEARS	DOE	579.12 GRD	?	?	C	UP	29.57	35.66	16.76	562.36 C	510111	
W2-19-17-30-06-NE	SIMPSON'S SEARS	DOE/SRC	579.12 GRD	?	?	C	UP	36.88	39.93	20.73	558.39 C	710900	
W2-19-17-30-08	REGINA BREWERY	HILL 30	576.07 GRD	?	?	C	IGS	?	85.34	12.19	583.88 C	290000	SEE P. 24
W2-19-17-30-09-NE	SWC REGINA 4	SWC/BECKIE 87	576.66 CAS	?	0.16	A	UP	32.31	33.98	18.49	558.17 B	871217	SCREEN + 5CM BELOW TOC
W2-19-17-30-10	WELL #2 CITY YARD	HILL 30	577.60 GRD	?	?	C	IGS	56.08	58.52	12.19	585.40 C	290000	SEE P. 81
W2-19-17-30-10	WESTERN MAN CO.	HILL 30	576.07 GRD	?	?	C	IGS	?	63.70	12.19	583.88 C	290000	SEE P. 24
W2-19-17-30-12-SW	CARLINGS BREWERY	DOE	579.12 GRD	?	?	C	IGS	45.72	60.35	18.29	560.83 C	600705	
W2-19-17-30-12-SW	CARLINGS BREWERY	DOE	579.12 GRD	?	?	C	IGS	54.56	59.13	21.03	558.09 C	621108	
W2-19-17-30-12-SW	R8 OBS(TH82-1)	MLM 1980	579.12 CAS	?	?	C	IGS	?	?	19.30	559.16 C	800000	
W2-19-17-30-12-SW	R8 OBS(TH82-1)	PWED	577.29 CAS	?	?	A	IGS			20.47	556.82 A	821202	
W2-19-17-30-12-SW	R8 OBS(TH82-1)	SWC/IPS	577.27 CAS	?	?	A	IGS			15.77	561.50 A	870414	
W2-19-17-30-12-SW	R8 OBS(TH82-1)									17.71	559.56 A	870812	
W2-19-17-30-12-SW	R8 OBS(TH82-1)									15.54	561.73 A	871123	
W2-19-17-30-12-SW	REG. R8	REGINA PWED	577.29 CAS	?	?	C	IGS	41.76	50.29	20.01	557.28 C	821202	DRILLED (SEE TH82-3)

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	DATE HT ACC	PM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WATERLV WLV DATE ACC	REMARKS	
W2 19-17-30 NE	C4	LISSEY 62/DOE	579.12 GRD	?	C	IGS	51.82	56.39	12.95	566.17 C	480800	DRILLED SEE P. 83
W2 19-17-30 NE	C4	LISSEY 62	579.12 PHP	-2.02C	IGS	IGS	51.82	56.39	19.02	560.10 C	620000	
W2 19-17-30 SW	PD #2 4 AVE CEM.	LISSEY 62/DOE	574.55 GRD	?	C	IGS	49.68	57.61	15.85	558.70 C	580000	SEE P. 84
W2 19-17-30 SW	PD #2 4 AVE CEM.	LISSEY 62	574.55 GRD	0.30 C	IGS	IGS	49.68	57.61	16.73	557.81 C	620300	SEE P. 84
W2 19-17-30 SW	T. EATONS	DOE	579.12 GRD	?	C	UP	20.42	28.96	13.72	565.40 C	380623	
W2 19-17-32	IMP OIL LTD 019	MOLLARD 60	582.17 GRD	?	C	UP	?	?	19.20	562.97 C	380500	
W2 19-17-32	IMP OIL LTD 019	MOLLARD 40	582.17 GRD	?	C	UP	?	?	18.90	563.27 C	420500	
W2 19-17-32	10-1AL	BECKIE 86	583.14 CAS	0.84 A	CM	17.46	18.93	15.55	567.59 A	850800		
W2 19-17-32	10 1B	BECKIE 86	583.02 CAS	0.61 A	UP	31.70	32.61	26.43	556.59 A	850700		
W2 19-17-32	10 2AL	BECKIE 86	582.94 CAS	0.69 A	CM	18.54	20.00	17.45	565.49 A	850803		
W2 19-17-32	10 2B	BECKIE 86	583.14 CAS	0.91 A	UP	32.61	34.13	26.52	556.62 A	850700		
W2 19-17-32 04 NW	10-4AL	BECKIE 86	581.26 CAS	0.59 A	CM	17.05	18.55	17.50	563.76 A	850800		
W2 19-17-32 04 NW	10 4B	BECKIE 86	581.21 CAS	0.61 A	UP	30.18	31.70	21.59	556.62 A	850700		
W2 19-17-32 05-NE	10-3AL	BECKIE 86	583.02 CAS	0.70 A	CM	18.04	19.51	16.82	566.20 A	850800		
W2 19-17-32 05-NE	10 3AL	SWC/IPS						DRY	DRY	A	870414	
W2 19-17-32 05-NE	10-3AL							16.72	566.30 A	870812		
W2 19-17-32 05 NE	10-3AU	SWC/IPS	582.92 ?	?	?	CM	?	16.73	566.29 A	871123		
W2 19-17-32 05 NE	10-3AU							16.50	566.42 A	870414		
W2 19-17-32 05 NE	10-3AU							16.58	566.34 A	870812		
W2 19-17-32 05 NE	10 3B	BECKIE 86	582.99 CAS	0.61 A	UP	31.39	32.92	16.56	566.36 A	871123		
W2 19-17-32 05 NE	10-3B	SWC/IPS						26.31	556.68 A	850700		
W2 19-17-32 05 NE	10-3B							25.77	557.22 A	870414		
W2 19-17-32 05 NE	10-3B							26.09	556.90 A	870812		
W2 19-17-32 05 NW	IMP OIL LTD 020	SRC TP FILE	583.20 CAS	?	B	UP	25.60	34.75	26.01	556.98 A	871123	DRILLED
W2 19-17-32 05 NW	IMP OIL LTD 020	SRC						20.42	562.66 B	430900		
W2 19-17-32 05 NW	IMP OIL LTD 021	DOE/SRC TP FILE	582.47 CAS	?	C	UP	26.82	33.22	24.08	559.00 C	530000	DRILLED
W2 19-17-32 05 NW	IMP OIL LTD 021	SRC	582.47 CAS	?	C	UP	25.91	30.48	21.34	561.14 C	500400	STALBERG E LOG
W2 19-17-32 05 SW	IMP OIL LTD 018	MOLLARD 60	582.78 CAS	?	C	UP	28.04	35.36	19.20	563.58 C	700526	
W2 19-17-32 05 SW	IMP OIL LTD 018	SRC TP FILE	582.78 CAS	?	B	UP	28.04	35.43	22.25	560.53 B	520500	DRILLED
W2 19-17-32 05 SW	IMP OIL LTD 018	SRC						23.16	559.61 C	530000		
W2 19-17-32 05 SW	IMP OIL LTD 018	SRC						24.99	557.78 C	710000		
W2 19-17-32 05 SW	IMP OIL LTD 018	MLM 80						25.02	557.75 B	800729	SEE APPENDIX D	
W2 19-17-32 05 SW	IMP OIL LTD 023	SRC DATA	582.17 GRD	?	C	UP	?	?	23.47	558.70 C	540000	
W2 19-17-32 05 SW	IMP OIL LTD 023	SRC TP FILE	582.17 CAS	0.46 B	UP	27.28	35.20	25.02	557.14 C	761200	DRILLED	
W2 19-17-32 12 NE	10 1AL	SWC/IPS	583.14 CAS	0.84 A	CM	17.46	18.93	25.91	556.26 B	660729		
W2 19-17-32 12 NE	10-1AL							15.36	567.78 A	870414		
W2 19-17-32 12 NE	10 1AL							15.40	567.74 A	870812		
W2 19-17-32 12 NE	10 1AL							15.30	567.84 A	871123		

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	PM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLY ELEV METERS	WATERLY ELEV ACC	WLV DATE	REMARKS
W2 19 17 32 12 NE	10-1AU	SWC/IPS	583.08	?	?	?	CM	?	16.77	15.31	587.77	A	870414
W2 19 17 32 12 NE	10-1AU									15.34	587.74	A	870812
W2 19 17 32 12 NE	10-1AU									15.28	587.80	A	871123
W2 19 17 32 12 NE	10-1B	SWC/IPS	583.02	CAS	0.61	A	UP	31.70	32.61	25.79	557.23	A	870414
W2 19 17 32 12 NE	10-1B									26.19	556.83	A	870812
W2 19 17 32 12 NE	10-1B									26.07	556.95	A	871123
W2 19 17 32 12 SW	IMP OIL LTD 025	DOE/SRC TP FIL	582.78	CAS	0.46	B	UP		45.50	26.91	555.87	B	720900
W2 19 17 32 12 SW	IMP OIL LTD 025	MLM 80	582.78	CAS	0.46	B	UP		45.50	25.59	557.19	B	800000
W2 19 17 32 15 NW	CAL 303	SWC/IPS	587.17	CAS	0.42	A	UP		39.34	29.93	557.24	A	870414
W2 19 17 32 15 NW	CAL 303									30.40	556.77	A	870812
W2 19 17 32 15 NW	CAL 303									30.30	556.87	A	871123
W2 19 17 32 15 NW	CAL 304	CLIFTON 85	587.16	GRD	0.32	A	CM	19.27	20.18	9.30	577.86	A	840925
W2 19 17 32 15 NW	CAL 304	SWC/IPS	587.16	CAS	0.41	A	CM	19.36	20.30	9.33	577.83	A	870414
W2 19 17 32 15 NW	CAL 304									9.20	577.97	A	870812
W2 19 17 32 15 NW	CAL 304									9.22	577.94	A	871123
W2 19 17 32 15 NW	CAL 307	CLIFTON 85	587.76	GRD	0.85	A	UP	35.90	36.81	31.24	556.52	A	840925
W2 19 17 32 16 NE	INTERPROV PIPE	DOE	582.17	GRD	?	C	UP	26.52	32.61	25.91	556.26	C	570712
W2 19 17 32 SW	ORS #1 102	FOR DATA SHEET	582.17	GRD	?	C	UP	?	?	27.29	554.88	C	730126
W2 19 17 33	H.W. LAIRD	WYNNE ROB 12	585.22	GRD	?	C	UP	?	?	23.47	561.75	C	120000
W2 19 17 33 14 SW	CAL 310	CLIFTON 85	586.75	GRD	0.57	A	CM	16.33	17.24	7.40	570.35	A	840925
W2 19 17 33 15 NW	H8	CLIFTON 85	580.88	CAS	1.60	A	CM	?	?	8.76	582.12	A	841100
W2 19 17 34 08 NE	H7	CLIFTON 85	589.26	CAS	1.30	A	CM	?	?	5.40	583.86	A	841100
W2 19 17 34 13 SW	H10	CLIFTON 85	586.83	CAS	1.15	A	CM	11.45	12.05	7.39	579.44	A	820923
W2 19 17 34 13 SW	H10	SWC/IPS								5.37	581.46	A	870312
W2 19 17 34 13 SW	H10									4.6	581.95	A	870812
W2 19 17 34 13 SW	H10									5.1	581.73	A	871123
W2 19 17 35 SW	D. GARDNER									1.5	589.79	C	810505
W2 19 17 36 SW	W.E. CROSS									17.68	576.68	C	730400
W2 19 18 02 NE		DOE	591.31	GRD	?	C	CM	12.19	15.24	12.19	588.27	C	350000
W2 19 18 02 NE		DOE	594.36	GRD	?	C	?	58.52	60.05	?	588.87	C	350000
W2 19 18 02 NE		MACKAY 1936	600.46	GRD	?	C	CM	?	?	11.58	588.87	C	350000
W2 19 18 02 NE		MACKAY 1936	604.37	CAS	?	C	CM	22.10	23.48	16.82	587.55	A	871000
W2 19 18 02 11 NE	RCC 2A 87	SPMC	604.73	CAS	0.92	A	CM	22.71	24.08	17.74	586.99	A	871000
W2 19 18 02 12 NE	RCC 1A 87	SPMC	604.66	CAS	0.92	A	UP	46.18	47.55	45.08	559.58	A	871000
W2 19 18 02 12 NE	RCC 1B 87	SPMC	608.21	CAS	?	A	CM	22.71	24.08	19.16	587.05	A	871000
W2 19 18 02 12 NE	RCC 4A 87	SPMC	614.54	CAS	?	A	CM	21.49	22.87	17.49	587.05	A	871000
W2 19 18 02 12 SE	RCC 3A 87	SPMC	605.26	CAS	?	A	CM	24.03	25.40	18.08	586.91	A	871000
W2 19 18 02 12 SW	RCC 5A 87	SPMC	605.26	CAS	?	A	CM	23.70	25.22	18.57	586.69	A	880100
W2 19 18 02 12 SW	RCC 6A 87	WYNNE ROB 12	594.36	GRD	?	C	CM	?	?	11.28	583.08	C	120000
W2 19 18 03	ROWSTON												

WELL NEAR PW20
LOCATION SOUTH 1/2SCREEN 28.9 32.41.1 45.5
SCREEN 28.9 32.41.1 45.5

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	MLV DATE ACC YMMDD	REMARKS		
W2 19 18 03 03 NW	NW1	BECKIE 79	594.88	CAS	0.61	A	CM	16.02	19.07	11.04	583.84	A	790821	SOUTH SIDE LANDFILL
W2 19 18 03 03 NW	NW1	CLIFTON 85	594.88	CAS	0.61	A	CM	16.02	19.07	10.42	584.46	A	840500	SOUTH SIDE LANDFILL
W2 19 18 03 04 NW	NW3	BECKIE 79	594.25	CAS	0.35	A	CM	14.76	17.81	11.13	583.12	A	790821	SW CORNER LANDFILL
W2 19 18 03 04 NW	NW3	CLIFTON 85	594.25	CAS	0.35	A	CM	14.76	17.81	9.61	584.64	A	840500	SW CORNER LANDFILL
W2 19 18 03 04 SW	U.H. 72.1	DOE/SRC	594.36	GRD	?	C	UP	63.70	65.23	38.71	555.65	C	721020	SW CORNER LANDFILL
W2 19 18 03 05 SW	NW22	SMC/IPS	595.00	CAS	?	A	UP			37.12	557.88	A	870414	
W2 19 18 03 05 SW	NW22									37.46	557.54	A	870812	
W2 19 18 03 05 SW	NW44	MLM 85	594.82	CAS	0.60	A	UP	53.22	54.13	37.43	557.57	A	871123	
W2 19 18 03 05 SW	NW44	SMC/IPS								37.46	557.34	A	841109	SW CORNER LANDFILL
W2 19 18 03 05 SW	NW44									37.33	557.49	A	870414	
W2 19 18 03 06 SE	NW45	MLM 85	596.15	CAS	0.79	A	CM	17.82	18.73	37.31	557.51	A	871123	
W2 19 18 03 06 SE	NW45	SMC/IPS								10.95	585.20	A	841109	SE CORNER LANDFILL
W2 19 18 03 06 SE	NW45									11.44	584.71	A	870414	
W2 19 18 03 06 SE	NW45									11.56	584.59	A	870812	
W2 19 18 03 06 SE	NW46	MLM 85	596.05	CAS	0.69	A	UP	58.00	59.00	37.77	558.28	A	841109	SE CORNER LANDFILL
W2 19 18 03 06 SE	NW46	SMC/IPS								37.31	558.74	A	870414	
W2 19 18 03 06 SE	NW46									37.61	558.44	A	870812	
W2 19 18 03 09 SE	NW52	MLM 86	602.52	CAS	0.74	A	CM	21.77	22.99	37.51	558.44	A	871123	
W2 19 18 03 09 SE	NW52	SMC/IPS								16.31	586.21	A	861100	
W2 19 18 03 09 SE	NW52									16.35	586.17	A	870414	
W2 19 18 03 09 SE	NW52									16.36	586.16	A	870818	
W2 19 18 03 09 SE	NW53	MLM 86	602.40	CAS	0.76	A	UP	40.08	41.30	16.34	586.18	A	871123	
W2 19 18 03 09 SE	NW53	SMC/IPS								DRY	DRY	A	861100	DRY AS OF 8611
W2 19 18 03 09 SE	NW53									40.88	561.52	A	870414	
W2 19 18 03 09 SE	NW53									DRY	DRY	A	870812	
W2 19 18 03 10 SW	NW60	BECKIE 87	603.41	CAS		A	UP	50.36	51.74	DRY	DRY	A	871123	
W2 19 18 03 10 SW	NW60	PWED								43.91	559.50	A	871000	
W2 19 18 03 10 SW	NW61	BECKIE 87	603.56	CAS		A	CM	20.87	22.25	43.76	559.65	A	871021	
W2 19 18 03 10 SW	NW61	PWED								18.69	584.87	A	871000	
W2 19 18 03 11 SE	NW2									18.59	584.97	A	871021	
W2 19 18 03 11 SE	NW2	BECKIE 79	599.43	CAS	0.41	A	CM	25.62	27.14	15.43	584.00	A	790621	NE CORNER LANDFILL
W2 19 18 03 12 SE	NW49	CLIFTON 85	599.43	CAS	0.41	A	CM	25.62	27.14	14.76	584.67	A	840500	NE CORNER LANDFILL
W2 19 18 03 12 SE	NW50	MLM 85	597.92	CAS	0.64	A	UP	?	55.31					BARCAD SAMPLER
W2 19 18 03 12 NW	NW71	MLM 85	597.82	CAS	0.56	A	CM	?	21.09					BARCAD SAMPLER
W2 19 18 03 12 NW	NW71	BECKIE 87	601.59	CAS		A	CM							
W2 19 18 03 12 NW	NW71	PWED												
W2 19 18 03 13 NE	NW70	BECKIE 87	593.53	CAS		A	CM			19.00	583.59	A	871211	
W2 19 18 03 13 NE	NW70	PWED								9.38	584.15	A	871211	

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DATE ACC	PM TOP OP SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WATERLV DATE ACC YMMDD	REMARKS
W2 19 18 04 09 SE	W229	BECKIE 87	604.32	CAS	0.91 A	CM	25.45	26.82	22.68	583.48 A	871123	
W2 19 18 04 09 SW	W264	PWED							21.18	604.32 A	871000	
W2 19 18 04 09 SW	W264	CLIFTON 85	596.58	GRD	0.79 A	UP	55.02	55.93	21.08	583.24 A	871021	
W2 19 18 04 11 NW	CAL 309	BECKIE 87	603.85	CAS	0.58 A	CM	23.88	25.25	39.81	556.77 A	840925	
W2 19 18 04 12 SE	W265	PWED							21.13	582.72 A	871000	
W2 19 18 04 14 SE	DOE TEST HOLE	SRC	603.50	GRD	?	C	?	?	20.93	582.92 A	871021	
W2 19 18 04 SE		MACKAY 1936	591.31	GRD	?	C	?	?	20.73	582.78 C	741003	SEE E LOG
W2 19 18 05 01 SW	CCRL 004	DOE/SRC	587.30	GRD	?	A	37.49	43.59	25.91	561.39 B	530700	DRILLED
W2 19 18 05 01 SW	CCRL 004	DOE/SRC							28.35	558.95 A	590603	
W2 19 18 05 01 SW	CCRL 004	SRC TP FILE							29.72	557.58 B	651123	
W2 19 18 05 01 SW	CCRL 005	CLIFTON 85							?	556.33 B	841100	
W3 19 18 05 01 SW	CCRL 005	PWED	588.33	CAS	0.44 A	UP	40.61	45.36	27.71	560.62 A	531007	SEE CURL REPORT
W2 19 18 05 03 SE	CCRL 007	SRC TP FILE							30.30	558.03 A	590603	
W2 19 18 05 04 SE	CAL 106	CLIFTON 85	585.85	CAS	?	C	38.10	79.25	28.50	567.36 B	680426	DRILLED
W2 19 18 05 04 SE	CAL 106	CLIFTON 85	584.20	GRD	0.64 A	CM	9.33	15.43	12.55	571.83 A	820825	
W2 19 18 05 07 SE	CCRL 006	SRC TP FILE	587.41	GRD	0.24 B	UP	35.66	42.67	12.37	571.81 A	841100	
W2 19 18 05 07 SE	CCRL 006	SRC TP FILE	587.41						28.78	558.63 B	610827	DRILLED
W2 19 18 05 07 SE	CCRL 006	SRC							29.63	557.78 B	650500	
W2 19 18 05 07 SE	CCRL 006	CLIFTON 85	587.41	CAS	?	A	35.66	42.67	30.48	557.17 B	670602	
W2 19 18 05 13 SE	T. MCEACHEN	SRC	591.31	GRD	?	C	?	?	?	556.49 B	841100	
W2 19 18 05 SE	CCRL	DOE	586.74	GRD	?	C	?	43.28	15.54	575.77 C	730400	SWL FROM E LOG
W2 19 18 05 SE	CCRL 003	DOE	588.26	GRD	?	C	?	47.85	24.38	562.36 C	390700	
W2 19 18 06	A. ROE	WYNNE ROB 12	586.74	GRD	?	C	?	?	30.10	558.09 C	500927	
W2 19 18 06	BUTLER	WYNNE ROB 12	579.12	GRD	?	C	?	36.58	18.29	568.45 C	120000	LOCATION SOUTH 1/2
W2 19 18 06 01 SE	MP1 AL	BECKIE 86	582.93	CAS	-0.10 A	CM	17.15	18.68	14.33	564.79 C	120000	
W2 19 18 06 01 SE	MP1 AL	SWC/IPS							12.75	570.18 A	850800	
W2 19 18 06 01 SE	MP1 AL	SWC/IPS	582.80	CAS	0.13 A	CM	12.49	13.92	12.55	570.38 A	870414	
W2 19 18 06 01 SE	MP1 AU								12.54	570.39 A	870812	
W2 19 18 06 01 SE	MP1 AU								12.53	570.40 A	871123	
W2 19 18 06 01 SE	MP1 AU								12.43	570.37 A	870414	
W2 19 18 06 01 SE	MP1 AU								12.46	570.34 A	870812	
W2 19 18 06 01 SE	MP1 B	BECKIE 86	583.01	CAS	-0.05 A	UP	31.95	33.48	12.39	570.41 A	871123	
W2 19 18 06 01 SE	MP1 B	SWC/IPS							27.32	555.69 A	850700	
W2 19 18 06 01 SE	MP1 B								26.45	556.56 A	870414	
W2 19 18 06 01 SE	MP1 B								26.99	556.02 A	870812	
W2 19 18 06 01 SE	MP1 B								26.70	556.31 A	871123	
W2 19 18 06 01 SE	REG. R5	DOE	583.89	GRD	?	C	?	48.77	27.43	556.26 C	680100	DRILLED
W2 19 18 06 02 SE	MP 2AL	BECKIE 86	581.28	CAS	-0.15 A	CM	15.79	17.31	14.52	566.76 A	850800	

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	MLV DATE ACC	REMARKS
W2 19 18 06 02 SE	MP 2B	BECKIE 86	581.86 CAS	-0.10 A	UP		33.73	35.26	26.17	555.89 A	850700	
W2 19 18 06 06 NE	REG. 86	DOE	586.74 GRD	? C	?		33.53	42.67	27.74	559.00 C	680200	DRILLED
W2 19 18 06 07 NE	MP 3AL	BECKIE 86	584.89 GRD	? A	CM		18.59	20.12	13.42	571.47 A	850800	
W2 19 18 06 08 NE	MP 4AL	BECKIE 86	585.85 GRD	? A	CM		18.56	20.09	12.73	573.12 A	850800	
W2 19 18 06 08 NE	MP 4B	BECKIE 86	585.73 CAS	-0.03 A	UP		35.94	37.46	29.95	555.78 A	850700	
W2 19 18 06 08 NE	TH59 1	MOLLARD 60	583.78 CAS	? H	UP		24.38	32.31	25.09	558.70 H	590000	? SCREEN ? WL.
W2 19 18 06 SW	C OF REGINA	PIEZ#16 DOE	586.74 GRD	? C	UP		39.62	41.15	27.43	559.31 C	671003	2" OBS
W2 19 18 06 SW	C OF REGINA	PIEZ#18 DOE	586.74 GRD	? C	UP		38.10	42.67	27.13	559.61 C	671025	6" OBS WELL
W2 19 18 07 11 NE	H86 1	HARDY/HBT 86	586.32 GRD	? C	CM		24.00	36.00	26.20	572.12 C	860630	
W2 19 18 07 11 NE	H86 1	SMC/IPS	589.41 CAS	0.66 A	CM		24.66	36.66	26.56	572.85 A	870312	
W2 19 18 07 11 NE	H86 1								26.59	572.82 A	870414	
W2 19 18 07 11 NE	H86 1								26.65	572.76 A	870812	
W2 19 18 07 11 NE	H86 1								26.60	572.81 A	871123	
W2 19 18 07 12 NW	H27	CLIPTON 85	588.18 CAS	0.58 A	CM		27.30	29.30	26.42	571.76 A	841100	
W2 19 18 07 NE	O. WILLIAMS	DOE	589.48 GRD	? C	UP		48.18	49.68	32.92	558.56 C	630529	
W2 19 18 08 05 NW	SMC REGINA 1	SMC/BECKIE 87	600.41 CAS	0.10 A	CM		27.89	29.58	24.88	575.53 B	871215	SCREEN + 5CM BELOW TUC
W2 19 18 08 11 SW	H12B	CLIPTON 85	594.91 CAS	0.01 A	CM		17.60	18.60	18.00	576.91 B	821213	
W2 19 18 08 12 NW	H21A	REGINA 83	592.80 CAS	0.56 A	F		77.96	83.96	30.60	562.20 B	830300	
W2 19 18 08 12 NW	H21A	SMC/IPS							29.96	562.84 A	870414	PROTECTIVE CASING 592.91
W2 19 18 08 12 NW	H21A								30.01	562.79 A	870812	
W2 19 18 08 12 NW	H21A								30.00	562.80 A	871123	
W2 19 18 08 12 NW	H21B	CLIPTON 85	592.89 CAS	0.61 A	UP		45.11	52.75	36.20	558.69 A	841100	
W2 19 18 08 12 NW	H21B	SMC/IPS							35.52	557.37 A	870414	
W2 19 18 08 12 NW	H21B								35.95	556.94 A	870812	
W2 19 18 08 12 NW	H21B								35.67	557.22 A	871123	
W2 19 18 08 12 NW	H21B								18.02	575.15 A	841100	
W2 19 18 08 12 NW	H21C	CLIPTON 85	593.17 CAS	0.94 A	CM		14.34	20.44	17.89	575.28 A	870414	
W2 19 18 08 12 NW	H21C	SMC/IPS							17.96	575.21 A	870812	
W2 19 18 08 12 NW	H21C								17.92	575.25 A	871123	
W2 19 18 08 12 NW	H23	CLIPTON 85	595.40 CAS	0.92 A	CM		13.87	18.87	13.36	582.04 A	830326	
W2 19 18 08 12 NW	H23	SMC/IPS							13.05	582.35 A	870312	
W2 19 18 08 12 NW	H23								13.04	582.36 A	870414	
W2 19 18 08 12 NW	H23								13.13	582.27 A	870812	
W2 19 18 08 12 NW	H23								13.09	582.31 A	871123	
W2 19 18 08 12 NW	H23								29.27	563.88 C	810602	
W2 19 18 10 01 NW	OBS 2 81	BECKIE 81	593.15 CAS	1.11 A	UP		47.41	48.31	29.87	563.28 A	870414	
W2 19 18 10 01 NW	OBS 2 81	SMC/IPS							30.23	562.92 A	870812	
W2 19 18 10 01 NW	OBS 2 81								30.00	563.15 A	871123	
W2 19 18 10 01 NW	OBS 2 81								5.34	586.23 A	861210	
W2 19 18 11 06 NW	PIEZ 1	GROUND ENG 86	591.57 CAS	0.76 A	CM		?	9.00				

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	MLV DATE ACC YYYDDD	REMARKS
W2 19 18 11 06 NW	PIEZ 1	SWC/IPS							5.67	585.90 A	870414	
W2 19 18 11 06 NW	PIEZ 1								5.32	586.25 A	870812	
W2 19 18 11 06 NW	PIEZ 1								5.68	585.69 A	871123	
W2 19 18 12	CITY OF REGINA	DOE	594.36 GRD	?	C	?	54.25	55.78	13.72	580.64 C	610809	4" CASING
W2 19 18 12	REG. BC 3	DOE	594.36 GRD	?	C	?	44.50	46.33	6.71	587.65 C	610805	4" CASING
W2 19 18 12 07 NE	REG. BC 3	DOE	594.36 GRD	?	C	?	39.01	49.07	6.71	587.65 C	631100	DRILLED
W2 19 18 12 07 NW	REG. K3	MLM 80	598.93 GRD	?	C	?	?	?	6.40	592.53 C	800000	
W2 19 18 12 12 NE	REG. K3	LISSEY 62/DOE	590.40 GRD	?	B	?	18.29	29.87	3.96	586.44 C	290000	DRILLED
W2 19 18 12 12 NE	REG. K3	MLM 80	590.40 GRD	?	C	?	18.29	29.87	11.07	579.33 C	800000	
W2 19 18 12 13 NW	REG. BC 2	DOE	594.36 GRD	?	C	?	21.95	32.60	4.57	589.79 C	620300	
W2 19 18 12 13 NW	REG. BC 2	MLM 80							4.79	589.57 C	800000	DRILLED
W2 19 18 12 16 NE	REG. BC 2	PWED							0.00	594.36 C	861211	1 OBS WELL
W2 19 18 12 16 NE	D8	BECKIE 1986	605.04 CAS	0.40 A	?	?	68.22	69.13	7.89	597.15 A	860512	FLOWING
W2 19 18 12 16 NE	D8	SWC/IPS							7.73	597.31 A	870414	
W2 19 18 12 16 NE	D8								9.93	595.11 A	870812	
W2 19 18 12 16 NE	D8								7.60	597.44 A	871123	
W2 19 18 12 NE	CITY OF REGINA	DOE	601.98 GRD	?	C	?	42.67	47.24	13.41	586.37 C	610000	6" CASING
W2 19 18 12 NW	CITY OF REGINA	DOE	594.36 GRD	?	C	?	28.65	33.53	7.01	587.35 C	611023	6" CASING
W2 19 18 12 NW	TH1 H61	LISSEY 62	592.47 GRD	0.30 A	?	?	28.96	33.53	6.49	585.98 A	611031	
W2 19 18 13 02 SE	REG. BC 4	PWED	594.09 CAS	?	B	?	27.43	42.67	3.84	590.25 B	780203	DRILLED
W2 19 18 13 02 SE	REG. BC 4	PWED							0.00	594.09 B	851011	FLOWING
W2 19 18 13 02 SE	REG. BC 4	PWED							0.00	594.09 B	861213	FLOWING
W2 19 18 13 02 SE	REG. BC191	LISSEY 62	594.09 PHP	-2.23B	?	?	34.44	43.59	0.00	594.09 B	871023	FLOWING
W2 19 18 13 02 SE	REG. BC191	C OF REGINA	594.09 CAS	?	B	?	34.44	43.59	0.40	593.89 B	440712	P 81
W2 19 18 13 02 SE	REG. BC191	LISSEY 62	594.09 PHP	-2.23B	?	?	34.44	43.59	0.00	594.09 B	591006	FLOWING
W2 19 18 13 05 SE	REG. BC192	DOE	593.14 GRD	?	C	?	23.16	32.31	3.69	590.40 A	611103	P 81
W2 19 18 15 05 SE	REG. BC192	PWED							6.40	586.74 C	490720	DRILLED
W2 19 18 15 05 SE	REG. BC192	PWED							0.00	593.14 C	591010	FLOWING
W2 19 18 13 05 SE	REG. BC192	PWED							0.00	593.14 C	851011	FLOWING
W2 19 18 13 05 SE	REG. BC192	PWED							0.00	593.14 C	861211	FLOWING
W2 19 18 13 05 SE	REG. BC192	PWED							0.00	593.14 C	871127	FLOWING
W2 19 18 13 SE	REG. BC179	DOE	594.06 GRD	?	C	?	?	?	1.83	592.23 C	350900	
W2 19 18 14 NE	F. MOLDING	DOE	601.98 GRD	?	C	?	24.38	25.60	9.75	592.23 C	631000	
W2 19 18 15 NW	R WATERSON	DOE	597.41 GRD	?	C	?	35.05	36.58	14.33	583.08 C	710714	
W2 19 18 22 SW	H. ZORA	DOE	594.36 GRD	?	C	?	19.61	21.34	9.14	585.22 C	640200	
W2 19 18 24 SE	M. M. KING	PFTB	609.60 GRD	?	C	UP	32.00	33.53	21.95	587.65 C	730400	
W2 19 18 34 NW	B. RLYTHE	DOE	609.60 GRD	?	C	?	29.26	30.78	7.92	601.68 C	640330	
W2 19 19 01 06	R. GAGEL	PFTB	629.41 GRD	?	C	E	57.30	60.35	24.38	605.03 C	800612	
W2 19 19 21 SE	G. GABEL	SWC	624.84 GRD	?	C	?	36.27	37.80	12.80	612.04 C	870727	

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DATE ACC	FM TOP OF METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	MLV ACC	DATE YMMDD	REMARKS
W2 19 19 26 08 SE	G. TATOIV	SMC	630.94 GRD	?	?	C	?	35.05	36.58	26.52	604.42 C	840710	SMV WHEN DRILLED
W2 19 19 31 12 SE	9G	LISSEY 62	594.97 PHF	0.15 C	LP	?	LP	28.96	35.36	0.00	594.97 C	440900	DRILLED
W2 19 19 31 12 SE	9G	LISSEY 62	594.97 PHF	0.15 A	LP	?	LP	28.96	35.36	1.32	593.75 A	441027	OTHER WELLS PUMPING
W2 19 19 31 12 SE	REG. M2	MOLLARD 67A	595.00 PHF	?	A	LP	LP	28.96	35.36	11.38	583.62 A	670422	FLOWING WHEN DRILLED
W2 19 19 31 12 SW	REG. M3A	REGINA PMED	594.01 GRD	?	B	LP	LP	20.24	26.34	0.00	594.01 B	620900	FLOWING WHEN DRILLED
W2 19 19 31 12 SW	REG. M3A	REGINA PMED	593.20 GRD	?	A	LP	LP	29.15	33.72	0.00	593.20 B	621000	FLOWING
W2 19 19 31 12 SW	REG. M4	REGINA PMED	593.20							0.00	593.20 B	851011	FLOWING WHEN DRILLED
W2 19 19 31 12 SW	REG. M4	REGINA PMED	592.59 GRD	?	A	LP	LP	24.17	28.74	0.00	592.59 B	621000	FLOWING
W2 19 19 31 13 NW	REG. 14A	REGINA PMED	597.83 GRD	?	A	LP	LP	38.40	44.50	0.00	597.83 B	400800	FLOWING WHEN DRILLED
W2 19 19 31 13 NW	REG. M1	REGINA PMED	596.97 GRD	?	B	LP	LP	33.53	42.06	1.52	595.45 B	620900	SMV WHEN DRILLED
W2 19 19 31 14 NE	REG. P2	MOLLARD 67A	601.46 GRD	?	A	LP	LP	35.36	48.77	10.46	591.00 A	670421	DRILLED
W2 19 19 31 14 NE	REG. P2	MLM 80		3.04						12.19	589.27 A	800000	OTHER WELLS PUMPING
W2 19 19 31 14 NE	TRIAL WELL 1-67	MOLLARD 67A	601.57 GRD	0.33 A	LP	?	LP	39.62	48.77	9.83	591.74 A	670328	SEE P. 97
W2 19 19 31 SW	WELL 1	HILL 30	598.63 GRD	?	C	?	?	4.57	13.72	3.05	601.68 C	290000	SEE P. 97
W2 19 19 31 SW	WELL 2	HILL 30	594.97 GRD	?	C	?	?	15.24	17.98	5.79	600.76 C	290000	
W2 19 19 32 11 NW	COUNTRY LANE FARMS	PFIB	617.22 GRD	?	C	LP	LP	63.70	65.23	27.74	589.48 C	790724	
W2 19 19 34 04 NW	G. HECKER	SMC	630.94 GRD	?	C	LP	LP	50.90	52.43	28.35	602.59 C	851017	
W2 19 20 05 04 NE	D. KLEIN	SRC	617.22 GRD	?	C	LP	LP	47.85	49.38	22.25	594.97 C	730400	
W2 19 20 05 08 SE	T. G. DAVIES	PFIB	627.89 GRD	?	C	LP	LP	63.70	65.23	28.96	598.93 C	730907	
W2 19 20 06 02 SW	E. K. WAGNER	SRC	609.60 GRD	?	C	LP	LP	33.53	35.05	6.71	602.89 C	700522	
W2 19 20 06 09 SE	H. RITTER	SRC	618.74 GRD	?	C	LP	LP	56.39	57.91	22.25	596.49 C	700400	
W2 19 20 10 04 NW	N. D. BOSWELL	PFIB	640.06 GRD	?	C	LP	LP	58.83	60.35	38.10	601.98 C	751118	
W2 19 20 10 15 NE	MASCANA ARCH CLUB	SRC	652.27 GRD	?	C	LP	LP	72.24	73.76	36.88	615.39 C	721000	
W2 19 20 19 12 SW	H. WAGNER	SRC	618.74 GRD	?	C	LP	LP	55.17	56.89	40.23	578.51 C	730700	
W2 19 20 29 12	L. WAGNER	SRC	649.22 GRD	?	C	LP	LP	74.07	75.59	48.16	601.06 C	840720	WL AT TOP OF AQUIFER
W2 19 20 31 16 NE	E. K. WAGNER	SRC	632.46 GRD	?	C	LP	LP	67.06	68.58	59.74	572.72 C	650802	
W2 19 20 33 07 SW	M. MALOWANY	SRC	640.06 GRD	?	C	LP	LP	69.19	70.71	60.96	579.12 C	851003	
W2 19 20 36 14 SW	R. W. INNES	SRC	615.70 GRD	?	C	LP	LP	77.42	80.47	29.26	586.44 C	690601	
W2 20 16 19 05 SW	K. CHESTON	PFIB	579.12 GRD	?	C	UP	UP	54.25	55.78	19.81	559.31 C	810812	
W2 20 16 20 05	EDNA SOKS FARMS LTD	PFIB	579.12 GRD	?	C	UP	UP	64.92	66.45	24.38	554.74 C	770310	
W2 20 16 22 06 NE	G. MCKENZIE	PFIB	573.02 GRD	?	C	UP	UP	53.34	54.86	22.86	550.16 C	740807	
W2 20 16 26 01 NE	D. AG. DUMELIE	SRC	569.98 GRD	?	C	?	?	18.29	21.34	9.45	560.53 C	870408	
W2 20 16 31 04 SW	J. SCHUBERT	SMC/IPS	575.67 CRIB	0.19 A	UP	?	?	30.67	32.19	17.06	558.61 A	870414	
W2 20 16 31 04 SW	J. SCHUBERT	SMC/IPS								17.01	558.67 A	870812	
W2 20 17 05 SW	DEPT PUBLIC WORKS	DOE	571.50 GRD	?	C	UP	UP	21.64	27.13	10.67	560.83 C	590720	OPEN HOLE
W2 20 17 07 NE	POISSANT	DOE	571.50 GRD	?	C	UP	?	24.38	?	14.33	557.17 C	320607	
W2 20 17 08 08 SE	PR PRIDE MUSHROOM	PFIB	571.50 GRD	?	C	UP	?	33.22	37.80	14.63	556.87 C	800106	
W2 20 17 13 NE	CITY OF REGINA	DOE	566.32 GRD	?	C	?	?	17.07	20.12	7.62	558.70 C	601004	

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WLV DATE ACC YVMDD	REMARKS
W2 20 17 16 NE	C. PETERSON	DOE	574.55 GRD	?	?	C	UP	51.82	54.86	19.81	554.74 C	800524
W2 20 17-16-NE	W. WEBS	DOE	574.55 GRD	?	?	C	UP	46.33	48.16	19.20	555.35 C	640817
W2 20 17 21 03 NE	WESTERN CLAY PROD	DOE	575.21 PHP	?	?	A	UP	42.67	45.72	18.29	558.35 A	561006
W2 20 17-21-03 NE	WESTERN CLAY PROD	SWC/IPS								18.35	558.29 A	870414
W2 20 17 21 03 NE	RM OF SHERWOOD	DOE	576.00 GRD	?	?	C	UP	39.62	42.67	18.19	558.45 A	871123
W2 20 17 22 16 SE	RCMP OBS #1	MOLLARD 73	573.02 GRD	0.00	C	UP	46.63	?	?	17.98	558.02 C	640703
W2 20 17 22-16 SE	RCMP OBS #2	MOLLARD 73	573.02 GRD	0.09	C	UP	49.38	52.43	14.14	558.88 C	730403	
W2 20 17 22 16 SE	RCMP PW3-73	MOLLARD 73	573.02 GRD	0.91	C	UP	40.23	55.17	14.17	558.85 C	730330	
W2 20 17-22 NE	RCMP	DOE	573.02 GRD	?	?	C	?	49.38	53.95	12.50	560.53 C	590319
W2 20 17 23 NW	REGINA GOLF CLUB	DOE	569.98 GRD	?	?	C	?	26.21	29.87	9.14	560.83 C	611000
W2 20 17 23 NW	SASK HOUSE REGINA	DOE	573.02 GRD	?	?	C	?	53.04	57.91	16.76	556.26 C	590707
W2 20 17 24 13 SW	REG. R3	DOE	576.62 GRD	?	?	A	?	51.82	59.44	18.29	558.33 B	600822
W2 20 17-24-13 SW	REG. R3	LISSEY 62	576.62 GRD	?	?	A	?	51.82	59.44	16.15	580.47 B	610309
W2 20 17 25 07 SE	7TH & CAMERON	SASK ARCHIVES	577.00 GRD	?	?	C	?	?	?	11.58	585.42 C	051209
W2 20-17-26 NE	TH8-BR60	LISSEY 62	576.89 GRD	0.73	A	IGS	57.91	60.96	16.06	580.83 B	601011	
W2 20 17 28 NW	INDUSTRIAL SCHOOL	WYNNIE ROB 12	573.02 GRD	?	?	C	UP	?	28.04	8.23	584.79 C	120000
W2 20 17 28 NW	INDUSTRIAL SCHOOL	DOE	571.50 GRD	?	?	C	UP	?	?	9.14	562.36 C	390830
W2 20 17 29 01 NE	PROCOR #19	SWC/IPS	576.71 CAS	0.85	A	UP	26.92	27.74	17.97	558.74 A	870410	
W2 20 17 29 01 NE	PROCOR #19								18.06	558.85 A	870414	
W2 20 17 29 01 NE	PROCOR #19								17.91	558.80 A	870812	
W2 20 17 29 01 NE	PROCOR #19								17.89	558.82 A	871123	
W2 20 17 29 02 SE	PROCOR TH4 74	MOLLARD 74	577.00 CAS	0.84	A	UP	27.86	29.48	17.70	559.30 A	741010	
W2 20 17 29 02 SE	PROCOR TH4 74	SWC/IPS							18.55	558.45 A	870414	
W2 20 17 29 02 SE	PROCOR TH4 74								18.70	558.30 A	870812	
W2 20 17 29 02 SE	PROCOR TH4 74								18.43	558.57 A	871123	
W2 20 17 29 07 NE	PROCOR TH2 74	MOLLARD 74	575.82 CAS	0.86	A	UP	23.68	25.30	16.59	559.23 A	741010	
W2 20 17 29 07 NE	PROCOR TH2 74	SWC/IPS							17.49	558.33 A	870414	
W2 20 17 29 07 NE	PROCOR TH2 74								17.70	558.13 A	870812	
W2 20 17 29 07 NE	PROCOR TH2 74								17.35	558.47 A	871123	
W2 20 17 29 09 SE	PROCOR TH3 74	MOLLARD 74	575.50 CAS	0.89	A	UP	20.64	22.24	16.33	559.17 A	741010	
W2 20 17 29 09 SE	PROCOR TH3 74	SWC/IPS							DRY	DRY	A	870414
W2 20 17-29-09-SE	PROCOR TH3 74								DRY	DRY	A	870812
W2 20 17-29-09-SE	PROCOR TH3 74								DRY	DRY	A	871123
W2 20 17 29 NE	HOME PETROLEUM	DOE	572.50 GRD	?	?	C	UP	29.87	31.39	15.85	556.65 C	800908
W2 20 17 29 SE	HYDRO GAS	DOE	577.29 GRD	?	?	C	UP	27.43	36.58	15.24	562.05 C	700828
W2 20 17 29 SW	COMINCO REGINA	DOE	575.00 GRD	?	?	C	E	55.78	57.30	17.37	557.63 C	640700
W2 20 17 29 SW	COMINCO REGINA	DOE	575.00 GRD	?	?	C	E	53.34	60.96	17.37	557.63 C	640700
W2 20 17 29 SW	COMINCO REGINA	DOE	575.00 GRD	?	?	C	E	42.06	47.85	15.54	559.46 C	640400

MULTIPLE SCREENS

SML WHEN DRILLED
1 OBS WELL

2 OBS WELLS

OPEN HOLE
SLOW (MOLLARD 74)

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	PM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV ELEV METERS	WATERLV ACC YVMMDD	REMARKS
W2 20 17 31 05	106 SEWAGE PLANT	GROUND ENG 73	572.11 GRD	?	?	B	?	12.95	?	12.50	559.61 B	730417
W2 20 17 31 05	108 SEWAGE PLANT	GROUND ENG 73	570.00 GRD	?	?	B	?	11.74	?	10.06	559.95 B	730417
W2 20 17 32 15 NW	REG. W4	DOE	574.55 GRD	0.00	C	UP		27.13	35.36	13.11	581.44 C	611200
W2 20 17 32 15 NW	REG. W4	JACKSON 64								16.00	558.55 C	630320
W2 20 17 32 15 NW	REG. W4	JACKSON 64								13.03	581.52 C	631202
W2 20 17 32 15 NW	REG. W4	MLM 80								18.59	555.96 C	800000
W2 20 17 32 15 NW	REG. W4	JACKSON 64								13.00	581.55 C	640323
W2 20 17 32 16 NE	REG. W3	DOE	574.24 GRD	0.00	C	UP		27.43	38.10	14.33	559.91 C	620200
W2 20 17 32 16 NE	REG. W3	JACKSON 64								14.23	560.02 C	631202
W2 20 17 32 16 NE	REG. W3	JACKSON 64								14.44	559.80 C	640323
W2 20 17 32 16 NE	REG. W3	MLM 80								18.29	555.96 C	800000
W2 20 17 32 16 NE	REG. W3	JACKSON 64								14.94	559.61 C	620500
W2 20 17 32 16 NE	REG. W3	DOE	574.55 GRD	?	C	UP		28.65	33.22	16.76	557.79 C	670320
W2 20 17 32 16 NE	REG. W3	DOE	574.55 GRD	?	C	UP		35.68	37.19	15.24	580.53 C	620300
W2 20 17 32 16 NE	REG. W3	JACKSON 64	575.77 GRD	0.00	C	UP				16.17	559.60 C	630926
W2 20 17 32 16 NE	REG. W3	DOE								15.03	580.22 A	611206
W2 20 17 32 16 NE	REG. W3	JACKSON 64								15.37	560.40 C	640323
W2 20 17 32 16 NE	REG. W3	DOE	575.25 CAS	?	A	UP		44.20	45.72	15.58	559.67 A	640302
W2 20 17 32 16 NE	REG. W3	JACKSON 64	575.16 GRD	0.76	C	UP				12.85	560.99 C	630300
W2 20 17 32 16 NE	REG. W3	DOE								12.82	580.82 C	631202
W2 20 17 32 16 NE	REG. W3	JACKSON 64								12.78	560.86 C	640323
W2 20 17 32 16 NE	REG. W3	DOE	575.55 CAS	1.04	A	UP		35.05	36.58	15.32	560.23 B	611116
W2 20 17 32 16 NE	REG. W3	JACKSON 64	575.55 CAS	1.04	A	UP		35.05	36.58	15.67	559.89 B	620508
W2 20 17 32 16 NE	REG. W3	DOE	576.07 GRD	?	C	UP		38.71	40.23	18.90	557.17 C	640602
W2 20 17 32 16 NE	REG. W3	JACKSON 64	576.07 GRD	?	C	UP		31.70	40.84	15.80	560.22 C	610724
W2 20 17 32 16 NE	REG. W3	DOE	576.07 GRD	0.46	C	UP		31.39	40.84	16.58	559.49 C	620100
W2 20 17 32 16 NE	REG. W3	JACKSON 64	576.07 GRD	0.88	B	UP		38.10	41.15	16.79	559.28 B	600928
W2 20 17 32 16 NE	REG. W3	DOE	573.04 CAS	?	A	UP				15.77	557.27 A	870414
W2 20 17 32 16 NE	REG. W3	JACKSON 64								17.71	555.33 A	870812
W2 20 17 32 16 NE	REG. W3	DOE	571.50 GRD	?	C	UP		25.60	31.70	15.54	557.50 A	871123
W2 20 17 32 16 NE	REG. W3	JACKSON 64	576.07 GRD	?	C	UP				15.85	555.65 C	680200
W2 20 17 32 16 NE	REG. W3	DOE	576.07 GRD	?	C	UP		?	?	12.19	563.88 C	320706
W2 20 17 32 16 NE	REG. W3	JACKSON 64	576.07 GRD	?	C	UP		28.04	32.61	15.85	560.22 C	671000
W2 20 17 32 16 NE	REG. W3	DOE	576.07 GRD	?	C	UP		31.39	32.92	16.15	559.92 C	671107
W2 20 17 32 16 NE	REG. W3	JACKSON 64	576.07 GRD	?	C	UP		29.57	32.61	15.85	560.22 C	671100
W2 20 17 32 16 NE	REG. W3	DOE	579.12 GRD	?	C	UP				32.00	559.31 C	120000
W2 20 17 32 16 NE	REG. W3	JACKSON 64	576.07 GRD	?	C	UP		30.78	32.61	19.20	556.87 C	120000
W2 20 17 32 16 NE	REG. W3	DOE	576.07 GRD	?	C	UP		47.23	52.72	20.19	555.99 A	831217
W2 20 17 32 16 NE	REG. W3	JACKSON 64	576.18 CAS	0.60	A	UP		47.23	52.72	18.08	558.08 A	870414
W2 20 17 32 16 NE	REG. W3	DOE	576.16 CAS	0.60	A	UP						

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT PM	SCREEN METERS	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	WATERLV DATE	REMARKS
W2 20-18-04-09 NW	W 5 OBS									18.36	557.80 A	870812	
W2 20-18-04-09 NW	W 5 OBS									17.86	558.30 A	871123	
W2 20-18-04-09 NW	REG. W5	REGINA PWED	575.67 CAS		?	B	UP	29.26	50.90	19.69	555.98 B	830517	DRILLED (SEE TRR2 3)
W2 20-18-04-SE	G. PISCH	DGE/SRC	574.55 GRD		?	C	UP	33.53	36.58	11.28	563.27 C	870822	
W2 20-18-07 SW		MACKAY 1936	575.46 GRD		?	C	CM	?	12.19	11.28	564.16 C	350000	
W2 20-18-08 NE		MACKAY 1936	576.38 GRD		?	C	UP	?	21.34	15.24	561.14 C	350000	
W2 20-18-08 NE		LISSEY 62	575.16 GRD		0.43 B	?	?	39.62	42.67	14.75	560.41 B	801027	1 OBS WELL
W2 20-18-09 13 NE	TH08 RH60	SMC/IPS	573.25 CAS		-2.36A	UP			27.74	15.15	558.10 A	870410	
W2 20-18-09 13 NE	WELLMAN B									15.67	557.58 A	870414	
W2 20-18-09 13 NE	WELLMAN B									15.34	557.91 A	870812	
W2 20-18-09 13 NE	WELLMAN B									17.25	557.59 A	870414	
W2 20-18-09 13 NE	WELLMAN C									16.92	557.92 A	870812	
W2 20-18-09 13 NE	WELLMAN C									16.54	558.30 A	871123	
W2 20-18-09 NW	WELLMAN C									9.14	566.93 C	350000	
W2 20-18-10-09 NW	H13A	MACKAY 1938	576.07 GRE		?	C	CM	?	15.24	27.42	556.48 A	841100	
W2 20-18-10-09 NW	H13A	CLIFTON 85	583.90 CAS		1.20 A	UP		40.62	43.82	26.80	557.10 A	870313	
W2 20-18-10-09 NW	H13A	SMC/IPS	583.90 CAS		0.62 A	UP		40.04	43.24	26.30	557.60 A	870414	
W2 20-18-10-09 NW	H13A									26.43	557.47 A	870812	
W2 20-18-10-09 NW	H13B									26.10	557.80 A	871123	
W2 20-18-10-09 NW	H13B	CLIFTON 85	584.39 CAS		1.40 A	CM		18.21	20.21	19.18	565.21 B	841100	
W2 20-18-10-09 NW	H13B	SMC/IPS	584.39 CAS		1.11 A	CM		19.31	23.95	18.40	565.99 A	870313	
W2 20-18-10-09 NW	H13B									18.51	565.88 A	870414	
W2 20-18-10-09 NW	H13B									18.58	565.81 A	870812	
W2 20-18-10-09 NW	H13B									18.74	565.85 A	871123	
W2 20-18-10-12 NW	H24A	CLIFTON 85	577.25 CAS		0.50 A	UP		26.70	32.80	19.89	557.36 A	841100	
W2 20-18-10-12 NW	H24A	SMC/IPS								19.25	558.00 A	870414	
W2 20-18-10-12 NW	H24A	SMC/IPS								19.28	557.97 A	870812	
W2 20-18-10-12 NW	H24A	SMC/IPS								19.35	557.78 A	871123	
W2 20-18-10-12 NW	H24B	CLIFTON 85	577.13 CAS		0.38 A	UP		26.58	32.68	15.00	562.16 A	841100	
W2 20-18-10-12 NW	H24B	SMC/IPS	577.16 CAS		0.45 A	CM		14.16	20.26	15.10	562.06 A	870414	
W2 20-18-10-12 NW	H24B									15.11	562.05 A	870812	
W2 20-18-10-12 NW	H24E									15.10	562.06 A	871123	
W2 20-18-10 SW	BELL									26.04	551.08 C	120000	
W2 20-18-11 09 NW	H86-7	WYNNE ROB 12	579.12 GRD		?	C	UP	?	37.19	25.60	567.79 C	860627	
W2 20-18-11 09 NW	H86-7	HARDY/BBT 86	593.39 CAS		0.40 C	CM		21.40	33.40	25.41	567.98 A	870313	
W2 20-18-11 09 NW	H86-7	SMC/IPS								25.48	567.91 A	870414	
W2 20-18-11 09 NW	H86-7									25.58	567.83 A	870812	
W2 20-18-11 09 NW	H86-7									25.53	567.86 A	871123	
W2 20-18-11 10 NW	H86-8	HARDY/BBT 86	587.26 GRD		0.40 C	CM		17.40	28.90	20.40	566.86 C	860628	

NEW DATUM

PROTECTIVE CASING 593.38

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME ON NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	FM ACC	PM ACC	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	MLV DATE ACC YVMMDD	REMARKS
W2 20-18-11 10 NW	H86-8	SWC/IPS	585.00	GRD	1.04	C	CM	18.30	24.40	20.25	587.01	A 870313	PROTECTIVE CASING 587.28
W2 20-18-11 10 NW	H86-8		584.91	GRD	?	C	CM	15.40	27.00	20.38	586.88	A 870414	
W2 20-18-11 10 NW	H86-8		585.41	CAS	0.46	A	CM	15.40	27.54	20.36	586.90	A 870812	
W2 20-18-11 11 NE	H22										586.15	C 841100	
W2 20-18-11 12 NW	H86-10									23.00	561.91	C 860825	
W2 20-18-11 12 NW	H86-10	SWC/IPS								19.65	585.76	A 870313	PROTECTIVE CASING 585.41
W2 20-18-11 12 NW	H86-10									19.65	585.76	A 870414	
W2 20-18-11 12 NW	H86-10									19.78	585.65	A 870812	
W2 20-18-11 12 NW	H86-10									19.75	565.66	A 711123	
W2 20-18-11 12 NW	H86-10									26.40	585.48	C 860826	
W2 20-18-11 14 NW	H86-9									25.74	586.14	A 870414	
W2 20-18-11 14 NW	H86-9									25.84	586.04	A 870812	
W2 20-18-11 14 NW	H86-9									25.79	586.09	A 871123	
W2 20-18-11 14 NW	H86-9									36.58	557.78	C 630810	
W2 20-18-11 NE	E. GILCHRIST									25.91	568.45	C 120000	
W2 20-18-12 09 NW	FORRESTER									23.20	571.71	C 860829	PROTEC CASING 594.91
W2 20-18-12 09 NW	H86-3									23.62	571.29	A 870313	
W2 20-18-12 09 NW	H86-3									23.79	571.12	A 870414	
W2 20-18-12 09 NW	H86-3									23.84	571.07	A 870812	
W2 20-18-12 09 NW	H86-3									23.78	571.13	A 871123	
W2 20-18-12 12 SW	H29									25.85	568.78	B 831017	
W2 20-18-12 16 NW	REG. R2									28.13	570.77	A 610912	
W2 20-18-12 16 NW	REG. R2									28.35	570.56	B 800000	
W2 20-18-12 16 NW	REG. R2									27.99	570.91	A 861105	
W2 20-18-12 16 NW	REG. R2									29.10	570.28	C 860918	
W2 20-18-12 16 NW	REG. R2									29.02	570.36	A 870313	
W2 20-18-12 16 NW	REG. R2									29.07	570.31	A 870414	
W2 20-18-12 16 NW	REG. R2									28.93	570.45	A 870812	
W2 20-18-12 16 NW	REG. R2									28.82	570.56	A 871123	
W2 20-18-12 16 NW	REG. R2									26.21	569.67	C 740700	
W2 20-18-12 16 NW	REG. R2									27.25	571.74	B 591112	
W2 20-18-12 16 NW	REG. R2									29.57	561.75	C 120000	
W2 20-18-12 SE	TH3 IWS 59									27.43	566.93	C 591214	
W2 20-18-13	R ARMOUR									22.56	571.80	C 630700	
W2 20-18-13	LIQUID CARBONIC									39.30	557.03	A 810806	
W2 20-18-13	SOUTHERN STEEL									36.91	557.42	A 811216	
W2 20-18-13 01 SW	CAL 501									38.89	557.44	A 870414	
W2 20-18-13 01 SW	CAL 501									39.30	557.03	A 870806	
W2 20-18-13 01 SW	CAL 501												SEE TESTHOLE E LOG RELIABLE DATUM ??
W2 20-18-13 01 SW	CAL 501												

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	PM	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV METERS	WATERLV ELEV METERS	MLV DATE ACC YMMDD	REMARKS
W2 20-20-16-02-SE	W. SMALL	SRC	573.02 GRD	GRD	?	C	E	128.63	131.67	79.55	493.47 C	731000	
W2 20-20-19-12-NW	W. M. MITCHELL	SMC	502.92 GRD	GRD	?	C	?	19.81	21.34	9.14	493.78 C	840407	
W2 20-20-20-07-NW	L. COWLES	SMC	498.35 GRD	GRD	?	C	?	14.02	21.64	12.80	485.56 C	860829	
W2 20-20-20-10-SW	J. RADU	SMC	493.78 GRD	GRD	?	C	?	35.05	36.58	9.14	484.64 C	740417	
W2 20-20-21-NE	PUMP WELL	LISSEY 62	514.20 GRD	GRD	0.61 C	E	E	66.45	69.49	19.35	494.64 C	601202	
W2 20-20-21-NE	TH17 BRGO	LISSEY 62	512.06 GRD	GRD	0.15 C	E	E	63.70	65.23	17.34	494.72 C	601202	
W2 20-20-22-06-NE	W. M. CATLEY	PFIB	582.17 GRD	GRD	?	C	E	130.76	132.28	85.34	496.82 C	730719	
W2 20-20-24-13-NW	R. G. HALL	PFIB	600.46 GRD	GRD	?	C	?	49.38	52.43	18.29	582.17 C	731000	
W2 20-20-27-04-SW	E. A. BODEN	SRC	579.12 GRD	GRD	?	C	E	124.36	127.41	83.32	495.30 C	690718	
W2 20-20-27-04-SW	T. TOWNSEND	SMC	579.12 GRD	GRD	?	C	?	129.24	132.28	48.77	530.35 C	860901	
W2 20-20-27-06	A. SMITH	SMC	588.26 GRD	GRD	?	C	?	41.15	42.67	18.29	522.73 C	860410	
W2 21-15-12-16-NE	A. M. LARSEN	PFIB	541.02 GRD	GRD	?	C	UP	64.01	65.53	30.48	557.78 C	731112	
W2 21-16-02-16-SE	D. GANSHORN	PFIB	583.69 GRD	GRD	?	C	UP	45.11	48.16	19.20	564.49 C	750612	
W2 21-16-03-NW	W. GANSHORN	PFIB	582.17 GRD	GRD	?	C	UP	30.78	32.31	23.77	558.39 C	760921	
W2 21-16-12-13-NW	G. SELBY	PFIB	582.17 GRD	GRD	?	C	UP	52.12	53.64	24.38	557.79 C	810812	
W2 21-16-24-04-SW	V. BARIL	PFIB	579.00 GRD	GRD	?	C	UP	29.87	31.30	22.86	556.14 C	770309	
W2 21-16-24-04-SW	V. BARIL	SMC	579.12 GRD	GRD	?	C	UP	27.43	28.96	22.86	556.26 C	860828	
W2 21-16-25-NE	SPC OBS #1	MOLLARD 65	574.55 CAS	CAS	?	C	UP	33.53	44.38	13.59	560.95 C	650309	SCR 33.5 36.2 42.3 44.4
W2 21-16-25-NE	SPC OBS #2	MOLLARD 65/SRC	574.55 CAS	CAS	?	C	UP	33.65	44.20	14.03	560.52 C	650309	SCR 33.5 36.42.7 44.2
W2 21-16-25-NE	SPC PUMP WELL	MOLLARD 65	574.55 CAS	CAS	?	C	UP	31.09	45.11	13.89	560.66 C	650309	SCR 44.8 37.8 42.1-45.1
W2 21-16-25-NE	C. GANSHORN	SMC/IPS	574.29 CAS	CAS	0.19 A	UP	UP	28.84	30.37	15.55	558.74 A	870407	
W2 21-16-36-08-SE	C. GANSHORN		574.29							15.55	558.74 A	870414	
W2 21-16-36-08-SE	C. GANSHORN		574.29							15.61	558.75 A	870812	
W2 21-16-36-08-SE	C. GANSHORN		571.93 CAS	CAS	2.38A	UP	UP	26.29	27.82	13.18	558.75 A	871123	NEW DATUM BELOW GROUND
W2 21-16-36-08-SE	C. GANSHORN	SRC	569.98 GRD	GRD	?	C	UP	44.81	47.85	16.46	553.52 C	670712	
W2 21-17-14-06-SE	M. PARLEY	SMC	573.02 GRD	GRD	?	C	UP	36.27	37.80	21.34	551.68 C	860619	
W2 21-17-27-02-SW	R. LIPSETT	PFIB	571.05 GRD	GRD	?	C	?	24.99	26.52	19.20	552.30 C	820503	
W2 21-18-02-12-NW	C. DELARUE	PFIB	571.50 GRD	GRD	?	C	S	57.30	58.83	25.91	545.59 C	800610	
W2 21-18-10-13-SE	V. MARTIN	PFIB	582.17 GRD	GRD	?	C	?	64.62	66.14	24.38	557.78 C	681218	
W2 21-18-14-14-NE	H. MARTIN	SRC	576.07 GRD	GRD	?	C	S	57.00	58.52	26.82	549.25 C	810626	
W2 21-18-16-01-SE	R. BROWN	PFIB	583.69 GRD	GRD	0.31 C	CM	CM	28.96	30.48	14.63	569.08 C	730600	
W2 21-18-24-NW	E. H. GHERASTIM	PFIB	579.12 GRD	GRD	?	C	CM	16.15	17.68	13.41	565.71 C	730800	
W2 21-18-26-02-SW	C. G. ENGLISH	PFIB	563.88 GRD	GRD	?	C	UP	35.05	36.58	9.14	554.74 C	750610	
W2 21-18-36-13-SW	V. HINTON	PFIB	563.88 GRD	GRD	?	C	UP	39.62	41.15	9.14	554.74 C	870427	
W2 21-18-36-14-NW	R. PETERS	SMC	563.88 GRD	GRD	?	C	?	35.66	37.19	28.96	528.82 C	800324	
W2 21-19-16-12-SW	D. ULMER	PFIB	557.78 GRD	GRD	?	C	?	?	?	20.42	528.22 C	600630	OPEN HOLE
W2 21-21-07-SE	UNITED CHURCH	DOE	548.64 GRD	GRD	?	C	?	?	?	30.48	510.54 C	820730	OPEN HOLE
W2 21-21-07-SW	BUENA VISTA	DOE	541.02 GRD	GRD	?	C	?	64.92	67.97	20.42	528.22 C	670820	FLOWING WELL
W2 21-21-07-SW	VILLAGE OF LUNSDEN	DOE	546.64 GRD	GRD	?	C	?	?	?	12.19	545.59 C	810603	
W2 21-21-08-NW	KANNATA SILTON	DOE	533.40 GRD	GRD	?	C	?	43.89	48.46				

TABLE B-1 LIST OF WATER LEVEL DATA FOR REGINA AREA (CONTINUED)

WELL LOCATION	WELL NAME OR NUMBER	DATA SOURCE	DATUM ELEV METERS	DATUM TYPE	CAS HT M	DAT ACC	FM SCREEN METERS	TOP OF SCREEN METERS	SCREEN BOTTOM METERS	STATIC WATERLV ELEV METERS	WATERLV ELEV METERS	MLV DATE	ACC YMMDD	REMARKS
W2-21-21-08-SE	BOSCO SOCIETY	DOE	546.64	GRD	?	C	?	121.92	124.96	84.73	463.91	C	800927	
W2-21-21-14-NE	ALBERT RUMPEL	DOE	556.26	GRD	?	C	?	42.67	44.20	15.24	541.02	C	801112	
FEB 5, 1988														

APPENDIX C
YEARLY GROUNDWATER
WITHDRAWALS

TABLE C-1 YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS

Notes

1. All withdrawals are in units of dam³ (cubic decameters or thousands of cubic meters).
2. Blanks in the tables mean that no information is available. Where withdrawals are known to be zero they are entered as such.
3. Source of data: The name and date sources refer to reports listed in the references section of the main report. DOE/SWC records refer to records collected and held by the Saskatchewan Department of the Environment (DOE) or the Saskatchewan Water Corporation (SWC). City data refers to records held by the Public Works and Engineering Department of the City of Regina. Data before 1960 also was obtained from original City of Regina ledgers held by the Saskatchewan Archives Board.
4. Estimated withdrawals are indicated by question marks.
5. Data from the report by Ball, 1978 were calculated by taking total water consumption minus water from Buffalo Pound. Note that in the years where Ball's data overlap with DOE/SWC records there are large discrepancies. These may be due to the fact that Ball's total consumption data presumably do not include unmetered consumption and leakage losses.
6. All detailed data for well field withdrawals are based on total running hours for each well and the rated production capacity of each well. There do not appear to be any metered well withdrawal data.

7. Ten inch line refers to flow from the Boggy Creek well field area through the original 10 inch line laid in 1904. This flow is in addition to the water pumped from Boggy Creek city wells through Tor Hill Reservoir.

TABLE C-1 LIST OF YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS

YEAR	BOGGY CREEK CITY WELLS		10" LINE		MALLORY SPRINGS CITY WELLS		MOUND SPRINGS CITY WELLS		CONDIE AQUIFER CITY WELL R-2		REGINA AQUIFER CITY WELLS		REGINA AQUIFER PRIVATE WELLS		REGINA TOTAL AQUIFER WELLS		TOTAL GROUNDWATER FROM CITY WELLS		SOURCE OF DATA
1908	0		747		0		0		0		0							747	BALL 1978
1909	0				0		0		0		0								
1910	0				0		0		0		0								
1911	0				0		0		0		0						1659		HALL 1978
1912					0		0		0		0								
1913					0		0		0		0						2199		BALL 1978
1914					0		0		0		0								
1915					0		0		0		0						3537		BALL 1978
1916					0		0		0		0						3996		BALL 1978
1917					0		0		0		0						4191		BALL 1978
1918					0		0		0		0						3957		CITY RECORDS
																	3960		BALL 1978
1919	2454				0		0		0		0						3414		CITY RECORDS
																	3414		BALL 1978
1920	2680				0		0		0		0						3940		CITY RECORDS
																	3941		BALL 1978
1921	2927				0		0		0		0						4147		CITY RECORDS
																	4187		BALL 1978
1922	2852				0		0		0		0						4328		CITY RECORDS
																	4328		BALL 1978
1923	2963				0		0		0		0						4541		CITY RECORDS
																	4541		BALL 1978

TABLE C-1 LIST OF YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (CONTINUED)

YEAR	BOGGY CREEK CITY WELLS	10" LINE	MALLORY SPRINGS CITY WELLS		MOUND SPRINGS CITY WELLS		CONDIE AQUIFER CITY WELL R 2		REGINA AQUIFER CITY WELLS		REGINA AQUIFER PRIVATE WELLS		REGINA AQUIFER GROUNDWATER TOTAL WELLS		SOURCE OF DATA
			WELLS	WELLS	WELLS	WELLS	WELLS	WELLS	WELLS	WELLS	WELLS	WELLS	WELLS	WELLS	
1924	2584		0	0	0	0	0	0	0				4465	4464	CITY RECORDS BALL 1978
1925	2805		0	0	0	0	0	0	0				4531	4532	CITY RECORDS BALL 1978
1926	3148	554	0	0	0	0	0	0	0				4816	4817	CITY RECORDS BALL 1978
1927	3247	670	0	0	0	0	0	0	0				4896	4897	CITY RECORDS BALL 1978
1928	3413	741		0	0	0	0	0	0				5125	5126	CITY RECORDS BALL 1978
1929	3353	746		0	0	0	0	0	0				5979	5980	CITY RECORDS BALL 1978
1930	3105	835	835	0	0	0	0	0	0			2042?	5497	6319	CITY RECORDS BALL 1978 HILL 1930
1931	3105	1013	798		0					382?	1660?		6001	6002	CITY RECORDS BALL 1978
1932	3713	861	1738		0								6997	6998	CITY RECORDS BALL 1978
1933	3450	628			0								6671	6673	CITY RECORDS BALL 1978
1934	3708	654			0								5839	5839	CITY RECORDS BALL 1978
1935	3759	667	964	134	0								5968	5970	CITY RECORDS BALL 1978

TABLE C-1 LIST OF YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (CONTINUED)

YEAR	BOGGY CREEK CITY WELLS	10" LINE	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELL R 2	REGINA AQUIFER CITY WELLS	REGINA AQUIFER PRIVATE WELLS	REGINA AQUIFER TOTAL WELLS	TOTAL GROUNDWATER FROM CITY WELLS	SOURCE OF DATA
1936	3201	742	1180	629	0				6202 6203	CITY RECORDS BALL 1978
1937	3469	957	1292	573	0				6638 6640	CITY DATA BALL 1978
1938	3692	961			0				6967 6968	CITY RECORDS BALL 1978
1939	3639	1037			0				6546 6546	CITY RECORDS BALL 1978
1940	3640	317			0				6625 6627	CITY RECORDS BALL 1978
1941	3723	403			0				7227 7229	CITY RECORDS BALL 1978
1942	3571	156	1254	905	0				7201 7203	CITY RECORDS BALL 1978
1943	3447	248	1220	1372	0				7657 7659	CITY RECORDS BALL 1978
1944	3554	457			0				7777 7950	CITY RECORDS BALL 1978
1945	4560	583			0				7709 7710	CITY RECORDS BALL 1978
1946	4590	729			0				7915 7917	CITY RECORDS BALL 1978
1947	2669	743			0				7644 7646	CITY RECORDS BALL 1978
1948	2930	863			0				8285 8237	CITY RECORDS BALL 1978

TABLE C-1 LIST OF YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (CONTINUED)

YEAR	BOGGY CREEK CITY WELLS	10" LINE	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELL R 2	REGINA AQUIFER		REGINA PRIVATE WELLS		REGINA TOTAL		SOURCE OF DATA	
						CITY WELLS	CITY WELLS	CITY WELLS	CITY WELLS	TOTAL WELLS	TOTAL WELLS		
1949	3303	931			0						9103 9117	CITY RECORDS BALL 1978	
1950	3583	728			0						8833 8835	CITY RECORDS BALL 1978	
1951	3662	581			0						8502 8529	CITY RECORDS BALL 1978	
1952	3400	515			0						8714 8719	CITY RECORDS BALL 1978	
1953	3688	569			0						9226 9292	CITY RECORDS BALL 1978	
1954					0						9369	BALL 1978	
1955					0						9640	BALL 1978	
1956	5807	708			0						10550	CITY RECORDS BALL 1978	
1957	5817	439			0						11090	CITY RECORDS BALL 1978	
1958	5796	530			0						10870	CITY RECORDS BALL 1978	
1959	4300	477			0						9370	CITY RECORDS BALL 1978	
1960					0				5000?			MOLLARD 1960 BALL 1978	
1961											8000	BALL 1978	
1962											8550	BALL 1978	

TABLE C-1 LIST OF YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (CONTINUED)

YEAR	BOGGY CREEK CITY WELLS	10" LINE	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELL R 2	REGINA AQUIFER CITY WELLS	REGINA PRIVATE WELLS	REGINA AQUIFER TOTAL WELLS	REGINA TOTAL FROM CITY WELLS	SOURCE OF DATA
1963									9140	BALL 1978
1964									10590	BALL 1978
1965									11100	BALL 1978
1966	5000?	1200?		2500?			6600?		11910 12000?	BALL 1978 MOLLARD 1966
1967							1803		14460	BALL 1978 DOE/SMC RECORDS
1968									9860	BALL 1978
1969	3209		176	1131	147	1318	2207	3525	5981 5318	DOE/SMC RECORDS BALL 1978
1970	2329		0	1140	69	592	2494	3086	4130 4910	DOE/SMC RECORDS BALL 1978
1971	2843		0	2062	88	719	2957	3676	5712 5680	DOE/SMC RECORDS BALL 1978
1972	2743		322	1372	44	679	2800	3479	5160 4820	DOE/SMC RECORDS BALL 1978
1973 1973	3446		216	1717	109	299	2538	2837	5787 3770	DOE/SMC RECORDS BALL 1978
1974	3901		155	1605	255	632	2602	3234	6548 3050	DOE/SMC RECORDS BALL 1978
1975	4204		68	2349	331	743	2247	2990	7695 6360	DOE/SMC RECORDS BALL 1978
1976	5244		2	2062	603	855	1367	2222	8766 7860	DOE/SMC RECORDS BALL 1978

TABLE C-1 LIST OF YEARLY GROUNDWATER WITHDRAWALS FROM WELL FIELDS OR AQUIFERS (CONTINUED)

YEAR	BOGGY CREEK CITY WELLS	10" LINE	MALLORY SPRINGS CITY WELLS	MOUND SPRINGS CITY WELLS	CONDIE AQUIFER CITY WELLS	REGINA AQUIFER CITY WELLS	REGINA AQUIFER PRIVATE WELLS	REGINA AQUIFER TOTAL WELLS	TOTAL GROUNDWATER FROM CITY WELLS	SOURCE OF DATA
1977	3899 3872		0 0	2267 2202	517 362	1597 1826	1397	2994	8280 8262 7820	DOE/SWC RECORDS CITY DATA BALL 1978
1978	5050 5021		0 0	2153 2121	661 476	1738 1892	1435	3173	9602 9510	DOE/SWC RECORDS CITY DATA
1979	4709 4720		577 579	2177 2182	492 493	3381 3391	1329	4710	11336 11365	DOE/SWC RECORDS CITY DATA
1980	4731 4803		1044 1047	2529 2336	476 478	5307 5321	1372	6679	14147 13985	DOE/SWC RECORDS CITY DATA
1981	3918 4015		504 506	2211 2218	163 163	3057 3069	1102	4159	9853 9971	DOE/SWC RECORDS CITY DATA
1982	4378 3981		485 486	1684 1575	125 111	3133 3123	1172	4305	9805 9276	DOE/SWC RECORDS CITY DATA
1983	4846		528	1804	120	2856	1141	3997	10154	DOE/SWC RECORDS CITY DATA
1984	5543		696	2016	159	4189	1164	5353	12603	DOE/SWC RECORDS CITY DATA
1985	4246		299	1819	20	2920	1079	3999	9304	SWC CITY DATA
1986	3731		489	1630	95	2237	1221	3458	8182	SWC CITY DATA
1987	2867		453	1488	88	1664	1158	2822	6560	SWC CITY DATA

ANNUAL WITHDRAWAL (DAM3 PER YEAR)

[illegible]

TABLE C-2 LIST OF YEARLY WITHDRAWALS FROM PRIVATE WELLS (CONTINUED)

NAME	WR FILE	DESCRIPTION OF WELL	WELL LOCATION	ANNUAL WITHDRAWAL (DAM3 PER YEAR)									
				1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
PRODUCER ABATTOIR				0.2	0.2	0.2	0.1						
CARLING BREWERIES		2 WELLS # -198'	W2-19 17-30 NW	166.6	196.2	145.6	143.1	172.8	178.9	160.4	171.5	155.5	140.7
DAD'S COOKIES		WELL #3'	W2-18 17-24 SW		2.5	2.5							
SILVERWOOD DAIRIES		WELL #187'	W2-19 17-19 NW				16	17.3	17.3				
IMPERIAL OIL ENT LTD		403 WELL #18-112'	W2-19 17-32 NW	1359.9	1648.6	1617.8	1337.7	1132.8	1046.4	0	0	0	0
GENSTAR CEMENT		369 WELL 97'	W2-19 18-03 NW	50.6	145.6	100	102.4	127.1	124.6	107.4	117.2	140.7	178.9
CONSUMERS CO OP REF		413 WELL #3 110'	W2-19 18-05 SE	911.9									
CONSUMERS CO OP REF		415 WELL #5 147'	W2-19 18-05 SE		504.7	529.4	545	730.5	625.6	649.1	618.2	644.1	417.1
CONSUMERS CO OP REF		416 WELL #6-130'	W2-19 18-05 SE		212.2	88.8	132	418.1	75.3	49.4	2.4		17.3
CONSUMERS CO OP REF		417 WELL #7-125'	W2-19 18-05 SE		244.3	313.4	257.9	1.2	156.7	154.3	45.7		
CONSUMERS CO OP REF		417 WELL #9	W2 19-18-05 SE										
WESTERN CLAY PROD		WELL 150'	W2 20-17 21 SW	1.2	2.5	2.5	3.7	2.5	19.7	244.3	386.2	464	573.8
COMINCO LTD		234 WELL 207'	W2 20 17 29 SW	2.5					2.5	2.5	55.5	30.9	1.2
IPSCO PIPE MILL			W2 20 18 13 SE	0.6									
TOTAL				2493.5	2956.8	2800.2	2537.9	2602.3	2247	1367.4	1396.7	1435.2	1329

TABLE C-2 LIST OF YEARLY WITHDRAWALS FROM PRIVATE WELLS (CONTINUED)

NAME	WR FILE	DESCRIPTION OF WELL	WELL LOCATION	ANNUAL WITHDRAWAL (DAM3 PER YEAR)									
				1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
PRODUCER ABATTOIR													
CARLING BREWERIES	2	WELLS # 198'	W2-19-17 30 NW	133.3	0	0	0	0	0				
DAD'S COOKIES		WELL #3'	W2-18-17 24-SW										
SILVERWOOD DAIRIES		WELL #87'	W2-19-17 19 NW										
IMPERIAL OIL ENT LTD	403	WELL #18 112'	W2 19-17-32 NW	0	0	0	0	0					
GENSTAR CEMENT	369	WELL #97'	W2 19 18 03 NW	212.2	167.8	145.6	170.3	171.5					
GENSTAR CEMENT	1527	WELL #2 62.5M	W2 19 18 10 SE						181	142.4	164.8		
CONSUMERS CO OP REF	413	WELL #3 110'	W2 19 18 05 SE										
CONSUMERS CO OP REF	415	WELL #5 147'	W2 19 18 05 SE	345.5	444.2	471.4	573.8	525.7	440.7	404.7	272.8		
CONSUMERS CO OP REF	416	WELL #6 130'	W2 19 18 05 SE	104.9	35.8	51.8	44.4	60.5					
CONSUMERS CO OP REF	417	WELL #7 125'	W2 19 18 05 SE										
CONSUMERS CO OP REF	417	WELL #10 29.9M	W2 19 17 32 SE							372.1	502.1		
CONSUMERS CO OP REF	414	WELL #9	W2-19-18 05 SE	575	454.1	503	352.9	406	457.4	301.4	217.8		
WESTERN CLAY PROD		WELL #150'	W2 20 17 21 SW	1.2									
COMINCO LTD	234	WELL 207'	W2 20 17 29 SW										
IPSCO PIPE MILL			W2 20 18 13 SE										

APPENDIX D
WATER QUALITY DATA

TABLE D-1 WATER QUALITY DATA

Notes

All presently available chemical analyses of groundwater in the Regina area have been tabulated and are arranged according to land location in Table D-1. This Table only includes those analyses which have an error in the ionic balance of less than five percent. Based on the present knowledge, the Table also indicates from which aquifer zone the sample was taken. The source of water quality data is provided as well as the well or piezometer name. The references are listed in Section 10 of this report.

Abbreviations

uS/cm	means electrical conductivity at 25 degrees Celcius
N/D	means aquifer zone not determined
Condie	means Condie Aquifer
U.FL.	means Upper Floral Sand and Gravel aquifer zones
L.FL.	means Lower Floral Sand and Gravel aquifer zones
IGS	means Interglacial Sediments aquifer zone
Empress	means aquifer zone formed by Empress Group sediments
S.	means aquifer zone within the Sutherland Group
(1)	means electrical conductivity values available at ambient groundwater temperatures but not at 25 degrees Celcius

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA

LAND LOCATION XX XX XX-XX-XX-XX YYMMDD	DATE	WELL NAME	WELL DEPTH FEET	PH	CA MG/L	MG	NA	K	FE	MN	CO3	HCO3	S04	CL	NO3 -NO3	PO4	P	COND. US/CM	SUM OF IONS	T.H. MG/L	T.A. MG/L	FORM BALANCE %	REFERENCE
W2-15-20-07--NW			3.7 N/D	7.90	69	48	2	12.0				458	11	4	7.0				611	370	376	1.12	RUTHERFORD, 1966
W2-15-20-11--NW			3.7 N/D	7.82	211	90	25	16.0				696	274	59	60.0				1431	898	571	0.80	RUTHERFORD, 1966
W2-15-20-16--NW			91.4 N/D	7.35	194	73	207	8.0				487	825	16					1810	785	400	1.42	RUTHERFORD, 1966
W2-15-20-16-15 NE 750212 HARDEN			92.0 N/D	7.35	200	73	176	11.0	6.80	1.03		482	789	7	0.1	0.08	0.56	1930	1747	800	385	1.31	SRC
W2-15-20-21-03 SE 750212 JONES			91.4 N/D	7.22	235	83	187	11.0	14.50	0.89		488	909	7	0.8	0.03	0.42	2100	1937	926	400	0.35	SRC
W2-16-18-01-13 NW 871015 KEX			57.9 N/D	7.36	316	137	76	11	0.11	2.50		452	1080	10	0.04	<0.03		2200	2085	1350	371	0.74	SRC
W2-16-18-09-12 NW 871015 OLSON			44.5 N/D	7.44	264	156	86	6.5	<0.01	2.60		682	870	9.3	0.04	0.18		2080	2077	1300	559	0.59	SRC
W2-16-18-28-09 SE 760919 McLEAN			7.6 N/D	7.80	228	683	264	11.0	5.40	0.22		497	3470	11	9.0	0.27	1.05	4330	5180	3370	407	0.99	SRC
W2-16-18-28-09 SE 871016 LONG			57.9 N/D	7.48	180	77	31	4.9	1.80	0.62		494	426	4	0.04	<0.03		1180	1219	767	404	0.86	SRC
W2-16-19-08-14 SE 750212 LINDENBACH			60.4 N/D	7.32	133	68	72	4.0	3.08	1.87		519	334	<1	0.1	0.06	0.52	1150	1136	611	425	0.09	SRC
W2-16-19-20-15 NE 750212 SCHULZ			96.3 N/D	7.19	312	151	122	11.0	30.60	0.49		616	1126	22	0.9		0.25	2210	2392	1400	505	0.90	SRC
W2-16-20-12--NE			19.8 N/D	7.52	274	120	53	10.0				595	755	8					1815	1179	488	0.79	RUTHERFORD, 1966
W2-16-20-31--SE			1.8 N/D		100	115	232					519	754	15					1735	725	425	0.17	RUTHERFORD, 1966
W2-17-15-26-03 SW 680627 LAJORD			4.9 N/D	6.95	113	67	237	9.0	1.24			401	708	28	NIL			1700	1564	731	329	0.94	SRC
W2-17-17-18--NE			60.4 N/D	7.65	166	84	411	9.0				610	632	35					1776	439	500	0.03	RUTHERFORD, 1966
W2-17-17-20--NW			54.9 N/D	7.52	290	92	310	9.0				755	1050	54					2354	761	500	0.82	RUTHERFORD, 1966
W2-17-17-21--NE			27.4 N/D	7.52	290	92	310	9.0				755	1050	54					2580	1104	619	0.01	RUTHERFORD, 1966
W2-17-17-22--NE			15.8 N/D	7.80	138	29	115	5.0				555	296	13					1151	464	405	4.08	RUTHERFORD, 1966
W2-17-17-25--NE			40.2 N/D	7.92	179	94	70	7.0				665	402	10					1427	835	545	0.86	RUTHERFORD, 1966
W2-17-17-33--SE			12.2 N/D	7.72	172	144	90	8.0				437	810	25	20.0				1706	1023	358	1.02	RUTHERFORD, 1966
W2-17-18-01--SW			18.3 N/D	7.22	239	962						531	3125	45					5174	1664	435	0.03	RUTHERFORD, 1966
W2-17-18-02--SE			67.1 N/D	7.50	230	122	172	10.0				682	810	16					2042	1078	559	1.31	RUTHERFORD, 1966
W2-17-18-07-16 NE 861103 BALCONTE			36.8 U.F.L.	7.71	81	32	9.8	4.5	<0.01	<0.01		326	77	4	3.1	0.03	0.28	627	538	336	267	0.63	SRC
W2-17-18-10-05 SE 871016 STIEFEL			39.9 U.F.L.	7.57	167	54	10	7.3	0.15	<0.01		474	197	30	70.8	0.06		1070	1010	637	389	1.70	SRC
W2-17-18-16-02 SW 861028 GRAY			38.1 U.F.L.	7.14	184	88	54	7.8	9.40	1.00		610	419	7	0.2	<0.03	0.32	1440	1381	816	500	0.08	SRC
W2-17-18-22-14 NE 871016 HUBER			68.9 U.F.L.	7.59	104	42	42	6	2.20	0.57		471	114	4	0.09	<0.03		830	786	431	386	1.99	SRC
W2-17-18-31-08 SE 871015 KUCH			47.2 U.F.L.	7.42	168	112	63	6.6	0.15	0.91		544	543	3.4	<0.02	<0.03		1580	1441	882	446	0.46	SRC
W2-17-19-02--SW			7.6 N/D	7.38	162	66	57	7.0	2.20	0.94		525	1133	59					2337	885	430	0.03	RUTHERFORD, 1966
W2-17-19-14-15 NW 750212 REICHEL			108.8 U.F.L.	6.98	352	165	171	12.0	39.10	0.63		647	1370	<1	0.8	<0.01	0.41	2750	2758	1556	453	0.36	SRC
W2-17-19-30--NE			14.3 N/D		522	252	51					293	2100	24					3242	2344	240	0.21	RUTHERFORD, 1966
W2-17-19-34--NE			30.5 N/D	7.95	240	144	85	6.0				625	840	16					1956	1193	512	0.92	RUTHERFORD, 1966
W2-17-19-34--SE			15.2 N/D	7.70	251	121	63	8.0				523	770	37					1773	1126	429	0.44	RUTHERFORD, 1966
W2-17-20-14--NW			64.6 N/D	7.50	249	134	149	6.0				742	850	21					2131	1174	608	0.08	RUTHERFORD, 1966
W2-18-17-04--NE			12.2 N/D		50	67	992					604	1682	222					3617	403	495	0.02	RUTHERFORD, 1966
W2-18-17-21-13 NW 750212 RANCK EHRL			15.8 CONDIE	7.38	162	66	57	7.0	2.20	0.94		416	472	14	0.2	0.03	0.25	1360	1218	725	341	0.33	SRC
W2-18-17-23--SE			9.1 CONDIE	8.05	156	126	53	10.0				389	275	65	418.0				1492	909	319	0.08	RUTHERFORD, 1966
W2-18-17-24-02 770000 TH 13-77			9.1 CONDIE	8.00	49	54	42		2.90	0.54		356	108	6	<1				618	348	292	2.72	BECKIE, 1977b
W2-18-17-24-03 770000 TH 8-77			10.4 CONDIE	8.00	26	123	68		3.50	0.78		354	395	8	<1				978	568	290	0.42	BECKIE, 1977b
W2-18-17-24-03 770000 TH 14-77			13.4 CONDIE	7.70	174	98	186		0.60	0.34		351	840	16	<1				1666	840	288	2.35	BECKIE, 1977b

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION XX XX-XX XX-XX XX-XX	DATE XX-XX-XX	WELL NAME	WELL DEPTH FEET	PH	CA MG/L	MG	NA	K	PE	MM	CO3 MG/L	SDM MG/L	CL MG/L	NO3 MG/L	PM	P	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	ERROR BALANCE %	REFERENCE
W2-18-18-20-01-SW	861029	BORSHNECK	51.8 L.P.L.	7.32	77	26	7.4	3.8	0.23	0.06	309	54	4	8.9	<0.03	0.20	530	491	301	253	0.43	SRC
W2-18-18-21-13-NW	861104	ABAR	65.2 L.P.L.	7.34	205	107	79	9.0	3.60	1.10	603	618	8	.0	<0.03	0.31	1750	1834	954	494	0.64	SRC
W2-18-18-21-14-NE	750212	BROUT	53.6 L.P.L.	7.20	163	81	41	7.0	3.78	1.50	569	357	4	0.4	<0.01	0.42	1250	1228	737	466	0.42	SRC
W2-18-18-23-08-NE	871016	NEIDER	85.6 S.	7.56	221	88	362	12	3.80	0.12	563	1140	63	0.04	0.06		2780	2453	911	462	0.61	SRC
W2-18-18-24-14-SW	861028	WARD	59.7 L.P.L.	7.20	277	89	134	11.0	0.47	0.65	599	834	10	.0	<0.03	0.28	2000	1855	1060	491	0.41	SRC
W2-18-18-26-08-NE	861028	CRUSON	70.1 L.P.L.	7.21	158	62	27	5.9	4.30	0.96	494	291	3	0.1	<0.03	0.25	1110	1047	649	405	0.19	SRC
W2-18-18-29-06-SE	861029	DEISELMAN	47.2 L.P.L.	7.13	246	113	67	7.8	0.88	2.20	641	666	8	0.1	<0.03	0.27	1780	1752	1080	525	0.15	SRC
W2-18-18-31-04-SE	750210	JORSEY	46.6 N/D	7.52	153	93	61	7.0	1.40	1.83	571	417	7	0.2	<0.01	0.40	1480	1313	764	468	0.40	SRC
W2-18-18-34-13-SW	861028	CARLEN	64.0 L.P.L.	7.22	229	97	70	5.8	0.07	3.10	618	579	7	0.1	<0.03	0.22	1650	1609	970	506	0.46	SRC
W2-18-19-05-03-SW	861028	BUNN	47.2 L.P.L.	7.15	208	87	38	7.1	0.38	2.10	517	489	15	6.2	<0.03	0.27	1440	1368	873	424	0.20	SRC
W2-18-19-29-08-NE	750211	SEITZ	60.7 U.P.L.	7.01	226	126	71	6	0.17	2.15	692	647	10	15.1	<0.01	0.32	1940	1796	1080	567	0.94	SRC
W2-18-19-31-14-SE	750211	SCHMIDT	64.0 L.P.L.	7.06	211	130	76	10.0	0.74	1.80	742	583	17	25.7	<0.01	0.38	1740	1798	1060	608	0.86	SRC
W2-18-20-22-SE			35.1 N/D	7.55	477	257	125	12.0			630	1911	19					3431	2251	516	0.04	RUTHERFORD, 1984
W2-19-16-33-NE			14.9 N/D		130	74	441				586	952	80					2263	629	480	0.12	RUTHERFORD, 1984
W2-19-16-34-13-NW	750210	HEGILL	20.1 U.P.L.	7.42	124	80	481	12.0	15.40	0.24	647	1055	70	0.4	0.15	0.24	2640	2485	638	530	0.83	SRC
W2-19-17-01-02-NW	750210	SCHNEIDER	30.5 U.P.L.	7.28	126	59	421	8.0	10.00	0.19	620	859	63	11.5	0.08	0.38	2440	2178	549	509	0.62	SRC
W2-19-17-01-03-NE	750212	SCHNEIDER	25.0 U.P.L.	7.34	122	56	429	9.0	1.00	0.15	633	857	59	0.1	0.10	0.35	2310	2167	534	519	0.54	SRC
W2-19-17-01-03-NW	750212	CURHAN	17.4 U.P.L.	7.68	117	60	423	10.0	0.60	4.37	654	839	71	0.2	0.09	0.34	2470	2180	538	536	1.31	SRC
W2-19-17-24-09-SE	750210	MILLER	78.9 EMP	7.38	157	69	372	10.0	13.10	1.06	666	863	59	0.2	<0.01	0.30	2350	2211	672	546	1.02	SRC
W2-19-17-25-12-NW	860000	REG. K1	42.4 U.P.L.		126	54	44	7.0		0.80	508	229	4				1000	971	539	415	1.35	MULLARD, 1966
W2-19-17-25-12-NW	860600	REG. K1	42.4 U.P.L.	7.40	107	61	50		0.20	0.82	421	280	4	<1				924	520	345	1.22	AESL, 1981
W2-19-17-25-12-NW	860600	REG. K1	42.4 U.P.L.	7.20	118	55	46		0.30	0.89	419	260	2	3.0				895	524	336	-0.71	AESL, 1981
W2-19-17-25-12-NW	860722	REG. K1	42.4 U.P.L.	7.60	115	62	46		0.50	0.81	445	250	14	<1				933	544	365	0.21	CITY OF REGINA
W2-19-17-25-12-NW	870309	REG. P1	42.7 U.P.L.	123	63	44	6.0				444	280	4				1100	974	564	364	0.15	MULLARD, 1967
W2-19-17-25-12-NW	830628	REG. P1	42.7 U.P.L.	7.30	121	57	46		0.50	0.98	442	268	2					937	540	362	0.60	AESL, 1981
W2-19-17-25-12-NW	830628	REG. P1	42.7 U.P.L.	7.50	117	63	46		0.50	0.88	447	268	8					948	552	366	0.26	CITY OF REGINA
W2-19-17-25-12-NW	840724	REG. P1	42.7 U.P.L.	7.50	126	57	40		0.50	1.00	440	260	6	<1				931	552	361	0.30	CITY OF REGINA
W2-19-17-25-12-NW	860722	REG. P1	42.7 U.P.L.	7.60	117	61	45		<0.1	0.86	444	250	8	<1				926	544	364	0.41	CITY OF REGINA
W2-19-17-25-13-NW	861029	REPETSKEI	43.3 U.P.L.	7.20	137	59	45	6.4	0.78	0.92	456	298	6	<0.02	0.06	0.34	1080	1010	584	374	0.20	SRC
W2-19-17-30-06-NE	750212	S-S 71-1	39.9 U.P.L.	7.22	129	64	84	8.0	2.40	0.55	455	377	15	1.2	0.13	0.36	1300	1137	584	373	0.68	SRC
W2-19-17-30-12-SW	860600	REG. R8	50.3 ICS	7.20	136	83	108	9.0	5.00	0.43	467	557	14	0.2	0.10	0.35	1700	1536	760	473	1.24	SRC
W2-19-17-30-12-SW	840724	REG. R8	50.3 ICS	7.51	166	86	136	9.0	4.30	0.48	583	581	14	0.1	0.08	0.43	1710	1570	765	486	0.73	SRC
W2-19-17-30-12-SW	860722	REG. R8	50.3 ICS	7.70	160	89	126		0.40	1.20	520	485	14	1.0				1327	880	426	1.06	AESL, 1981
W2-19-17-32-04-NW	850829	10 44I	20.0 CUNDIE	7.60	157	102	134		0.30	0.72	554	512	20	<1				1462	768	454	1.17	CITY OF REGINA
W2-19-17-32-04-NW	850829	10 4B	31.1 U.P.L.	7.50	160	71	118		0.30	0.53	573	570	24	<1				1562	812	470	0.27	CITY OF REGINA
W2-19-17-32-04-NW	860303	10 7AL	19.2 CUNDIE	7.30	156	61	156		0.80	1.28	578	945	30	4				2081	1368	474	0.38	BECKIE, 1986
W2-19-17-32-05-NW	741001	10L 020	32.0 U.P.L.	7.29	171	84	86	8.0	1.30	1.32	545	491	14	3.0	<0.05	0.30	1550	1405	773	447	0.58	SRC

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION	DATE	WELL NAME	WELL DEPTH PER	PH	CA	MG/L	NA	K	FE	MN	CU	CO	SO ₄	CL	NO ₃ -N	PO ₄	F	COND.	SUM OF IONS	T.H.	T.A.	ERROR BALANCE	REFERENCE		
XX-XX-XX-XX-XX-XX	YYMMDD		M			MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	US/CM	MG/L	MG/L	MG/L	%			
W2 19-17-32-05 NW 741001 IOL 021			33.2 U.P.L.	7.24	174	84	86	8.0	2.00	1.03			542	502	7	3.0	<0.05	0.30	1570	1409	779	444	0.15 SRC		
W2 19-17-32-05 NW 850829 IO 3AU			17.3 CONDIE	7.80	251	73	26			0.71			449	565	14	26			1405	928	368		0.70 HECKIE, 1986		
W2 19-17-32-05 NW 850829 IO 3AL			18.8 CONDIE	7.60	149	49	15			0.58			400	291	2	<1			1625	907	572	328	2.23 HECKIE, 1986		
W2 19-17-32-05 NW 850829 IO 3B			32.3 U.P.L.	7.80	194	84	135		0.50	1.32			566	600	22	<1				1603	828	464		0.16 HECKIE, 1986	
W2 19-17-32-05 NW 860303 IO 6AL			18.4 CONDIE	7.40	516	168	43		0.21	2.10			501	1440	70	<1			3450	2740	1940	411	1.56 HECKIE, 1986		
W2 19-17-32-05 SW 741001 IOL 018			34.1 U.P.L.	7.41	171	82	91	8.0	1.40	1.31			542	500	14	6.0	<0.05	0.30	1560	1417	764	444	0.92 SRC		
W2 19-17-32-05 SW 741001 IOL 024			33.5 U.P.L.	7.27	190	84	108	9.0	1.10	1.61			553	575	7	4.0	<0.05	0.30	1650	1533	819	453	0.01 SRC		
W2 19-17-32-05 SW 860303 IO 8AL			20.7 CONDIE	7.30	320	141	150		2.00				499	1140	58	<1			2450	2310	1380	409	0.80 HECKIE, 1986		
W2 19-17-32-12 SW 741001 IOL 025			45.5 U.P.L.	7.27	166	83	85	8.0	7.50	1.24			542	474	7	5.0	<0.05	0.30	1550	1379	758	444	0.09 SRC		
W2 19-17-32-12 SW 850829 IO 2AL			19.3 CONDIE	7.50	197	67	18			0.69			427	455	12	<1			2170	1177	768	350	2.08 HECKIE, 1986		
W2 19-17-32-12 SW 850829 IO 2B			33.2 U.P.L.	7.90	171	84	120		0.70	0.42			499	585	14	<1				1474	772	409	0.22 HECKIE, 1986		
W2 19-17-32-12 SW 860303 IO 5AU			17.4 CONDIE	8.00	198	47	30		0.80				370	404	32	<1			1082	688	303	1.07 HECKIE, 1986			
W2 19-17-32-12 SW 860303 IO 5AL			18.9 CONDIE	7.40	162	39	29		0.33	0.50			384	296	10	<1			10.30	921	564	315	0.73 HECKIE, 1986		
W2 19-17-32-12 NE 850829 IO 1AU			16.0 CONDIE	7.80	264	90	90		0.49				395	820	20	<1			1679	1032	324	0.79 HECKIE, 1986			
W2 19-17-32-12 NE 850829 IO 1AL			18.0 CONDIE	7.40	190	46	24		4.10	0.50			383	384	18	<1			1910	1050	664	314	1.62 HECKIE, 1986		
W2 19-17-32-12 NE 850825 IO 1B			32.0 U.P.L.	9.10	45	55	107		0.20	<0.01			76	470	14	<1				767	340	112	0.01 HECKIE, 1986		
W2 19-17-32-15 NW 841107 CAL 303			39.0 U.P.L.	7.50	152	84	110	7.4	0.07	0.98			528	505	16	<1	0.08		(1)	1404	724	432	0.39 CLIFTON, 1985		
W2 19-17-32-15 NW 850501 CAL 303			39.0 U.P.L.	7.60	165	75	98	11.0	0.10	1.44			495	460	12	<1			(1)	1318	720	406	2.48 CLIFTON, 1985		
W2 19-17-32-15 NW 841010 CAL 304			20.2 CONDIE	7.40	259	101	40	1.4	0.28	1.50			331	750	44	<1	0.07		(1)	1528	1064	272	-1.60 CLIFTON, 1985		
W2 19-17-32-15 NW 850502 CAL 304			20.2 CONDIE	7.50	264	90	40	11.0	0.30	1.95			322	730	36	<1	0.07		(1)	1495	1032	264	2.51 CLIFTON, 1985		
W2 19-17-32-16 C 821012 CAL 104			14.0 CONDIE	7.70	160	55	38	8.0	<0.1	1.00			356	360	28	<4			(1)	1006	628	292	-0.86 CLIFTON, 1985		
W2 19-17-32-16 C 841105 CAL 104			14.0 CONDIE	7.40	166	69	40	8.2	0.07	0.12			375	372	46	<1	0.07		(1)	1076	700	307	-2.31 CLIFTON, 1985		
W2 19-17-32-16 C 850430 CAL 104			14.0 CONDIE	7.60	166	63	35	11.0	0.20	0.24			347	372	56	<1			(1)	1050	676	284	-0.85 CLIFTON, 1985		
W2 19-17-32-16 NE 841010 CAL 307			36.8 U.P.L.	7.10	154	100	94	7.4	0.13	1.30			608	474	14	<1	0.09		(1)	1453	808	499	-1.13 CLIFTON, 1985		
W2 19-17-32-16 NE 850514 CAL 307			36.8 U.P.L.	7.27	171	95	88	7.4	0.06	1.40			571	479	12	<0.02	0.02		(1)	1425	817	468	-1.73 CLIFTON, 1985		
W2 19-17-33-13 NE 821006 CAL 103			13.7 CONDIE	7.60	179	58	49	9.0	<0.1	1.10			383	436	14	<4			(1)	1129	688	314	0.99 CLIFTON, 1985		
W2 19-17-33-13 NE 841108 CAL 103			13.7 CONDIE	7.30	176	74	41	8.9	0.16	1.00			375	520	16	<1			(1)	1212	744	307	1.58 CLIFTON, 1985		
W2 19-17-33-13 SW 841004 CAL 301			17.6 CONDIE	7.50	104	48	34	5.9	0.15	0.76			413	194	4	1.0	0.07		(1)	805	456	328	0.79 CLIFTON, 1985		
W2 19-17-33-13 SW 850508 CAL 301			17.6 CONDIE	7.70	107	37	26	8.0	2.00	0.82			364	153	<1	<1	0.08		(1)	698	420	298	2.99 CLIFTON, 1985		
W2 19-17-33-13 SW 841107 CAL 302			36.4 U.P.L.	7.00	136	95	87	7.2	0.16	1.10			525	460	14	<1			(1)	1327	734	430	0.25 CLIFTON, 1985		
W2 19-17-33-14 SW 841015 CAL 310			17.2 CONDIE	7.70	118	49	42	7.7	0.38	0.62			397	238	6	<1	0.04		(1)	859	496	325	1.32 CLIFTON, 1985		
W2 19-17-33-14 SW 850516 CAL 310			17.2 CONDIE	7.46	107	44	30	6.6	7.60	1.20			348	201	7	0.1	1.10		(1)	754	446	285	-1.51 CLIFTON, 1985		
W2 19-17-34-08 NE 831000 H7			8.6 CONDIE	8.00	292	68	76	9.4	<0.1	1.90			539	355	22	<4		0.26	1750	1604	1008	276	2.11 CITY OF REGINA		
W2 19-17-34-13 SW 831002 H10			10.9 CONDIE	7.52	175	71	79	7.3	<0.1	1.40			539	612	15	0	0.06	0.34	1430	1250	729	442	3.80 CITY OF REGINA		
W2 19-17-35-01 NE 861029 WESSNER			59.4 N/D	7.41	154	41	228	6.1	1.60	0.08			538	612	15	0		0.14	1750	1596	544	441	2.00 SRC		
W2 19-17-36-05 SW 750210 CROSS			59.9 N/D	7.35	96	67	189	6.0	3.87	0.10			547	458	4	0.2	0.10	0.20	1460	1371	513	448	0.12 SRC		
W2 19-18-03-03 NW 790530 MW1			19.8 CONDIE	7.40	147	70	46		0.60	1.04			366	460	8	0			1400	1099	656	300	2.29 HECKIE, 1982		
W2 19-18-03-03 NW 800517 MW1			19.8 CONDIE	8.15	187	64	45.5	14.3	0.04	1.16			368	481	21	0			1470	1182	730	368	0.90 HECKIE, 1982		
W2 19-18-03-03 NW 811216 MW1			19.8 CONDIE	7.80	192	83	50		6.70	0.33			373	600	12	<1				1317	820	306	0.96 HECKIE, 1982		

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION XX XX XX-XX-XX XX-XX-XX	DATE YYMMDD	WELL NAME	WELL AQUIT- DEPTH PER M	PH	CA MG/L	MG	NA MG/L	K MG/L	PE MG/L	MM MG/L	CU3 MG/L	SO4 MG/L	CL MG/L	NO3 -NO3 MG/L	PO4 MG/L	P US/CM	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	ERROR BALANCE %	REFERENCE
W2 19 18 03 04 NW 790601 MK3			18.9 CONDIE	7.30	262	135	55		0.10	1.40		378	880	42	0.3		2100	1754	1212	310	-1.66	BECKIE, 1982
W2 19 18 03 04 SW 750212 U.H. 72 1			65.2 U.FI.	7.25	168	79	81	7.0	4.60	1.34		530	467	7	3.5	0.02	0.50	1349	745	434	0.28	SRC
W2 19 18 03 05 NE 820720 MK26			19.3 CONDIE	7.30	256	126	208			0.60		708	700	230	<1			2229	1160	580	0.74	BECKIE, 1982
W2 19 18 03 05 NE 820720 MK27			16.1 CONDIE	7.70	272	131	129			0.29		549	820	140	<1			2041	1220	444	0.10	BECKIE, 1982
W2 19 18 03 05 NW 801216 MK15			16.7 CONDIE	7.80	275	113	49		0.04			534	880	48	39.9			1739	1152	432	0.48	BECKIE, 1980
W2 19 18 03 05 NW 801215 MK16			20.1 CONDIE	7.60	248	87	60		0.53			433	600	66	<4			1495	980	355	1.59	BECKIE, 1980
W2 19 18 03 05 NW 801215 MK17			22.9 CONDIE	7.50	235	87	59		0.47			386	670	34	<4			1471	944	316	0.50	BECKIE, 1980
W2 19 18 03 05 NW 811216 MK17			22.9 CONDIE	7.40	232	117	53		0.65			376	756	44	<1			1579	1060	308	0.78	BECKIE, 1982
W2 19 18 03 05 NW 801103 MK8			24.1 CONDIE	7.20	155	190	94			2.65		520	765	102	<4			1829	1168	426	0.23	BECKIE, 1980
W2 19 18 03 05 SW 801229 MK12			12.0 CONDIE	7.50	387	160			<0.1	4.75		503	1120	132	<4			2307	1623	412	4.15	BECKIE, 1980
W2 19 18 03 05 SW 801229 MK13			16.2 CONDIE	7.60	315	129	74		2.60	2.40		476	900	96	<4			1995	1320	380	0.51	BECKIE, 1980
W2 19 18 03 05 SW 811217 MK13			16.2 CONDIE	7.70	224	126	64		0.64			539	712	76	<1			1742	1080	412	2.94	BECKIE, 1982
W2 19 18 03 05 SW 801229 MK14			19.2 CONDIE	7.40	505	170	81		1.20	2.60		512	1550	76	<4			2894	1940	424	0.12	BECKIE, 1980
W2 19 18 03 05 SW 811217 MK14			19.2 CONDIE	7.60	536	193	80		0.89			525	1750	82	<1			3167	2136	430	1.34	BECKIE, 1982
W2 19 18 03 06 NE 820811 MK36			19.2 CONDIE	7.40	121	91	32		1.60	0.40		371	432	24	<1			1073	676	304	2.73	BECKIE, 1982
W2 19 18 03 06 NE 820811 MK37			15.8 CONDIE	7.80	152	66	32			0.06		388	384	18	2.0			1042	652	318	1.67	BECKIE, 1982
W2 19 18 03 11 SE 801216 MK18			17.4 CONDIE	7.70	286	120	44			0.10		405	700	130	141.8			1827	1208	332	2.08	BECKIE, 1980
W2 19 18 03 11 SE 801215 MK18			20.4 CONDIE	7.60	304	112	47		0.34			350	775	124				1712	1220	287	2.04	BECKIE, 1980
W2 19 18 03 11 SE 811217 MK19			20.4 CONDIE	7.30	315	129	40			0.02		395	828	130	54.0			1891	1320	324	0.32	BECKIE, 1982
W2 19 18 03 11 SE 801215 MK20			23.5 CONDIE	7.60	320	100	44		0.40			408	695	168	57.6			1793	1212	334	1.35	BECKIE, 1980
W2 19 18 03 11 SE 801215 MK21			26.8 CONDIE	7.50	368	125	67		4.60	0.96		517	685	278	26.6			2072	1436	424	0.89	BECKIE, 1980
W2 19 18 03 11 SE 820811 MK34			18.3 CONDIE	7.80	198	75	30		0.36			359	560	36	9.0			1287	804	294	3.74	BECKIE, 1982
W2 19 18 03 11 SE 820811 MK35			23.8 CONDIE	7.80	214	81	30		1.80	0.11		356	632	24	<1			1339	868	292	2.67	BECKIE, 1982
W2 19 18 03 11 SE 820811 MK38			22.3 CONDIE	7.60	291	73	130		1.80	0.12		517	504	306	<1			1823	1028	424	2.63	BECKIE, 1982
W2 19 18 03 11 SE 820811 MK39			18.7 CONDIE	7.20	280	102	158			9.42		532	592	300	<1			1973	1140	436	0.46	BECKIE, 1982
W2 19 18 03 11 SE 821223 MK40			21.3 CONDIE	7.20	256	120	47		0.27			490	584	264	4.0			1775	1156	402	4.75	BECKIE, 1982
W2 19 18 03 11 SE 801103 MK5			24.1 CONDIE	7.70	211	120	42		1.30	0.60		354	536	62	38.0			1466	948	318	3.31	BECKIE, 1982
W2 19 18 03 11 SE 811217 MK6			24.1 CONDIE	7.60	206	79	39		0.40	0.64		339	558	32	1.0			1255	840	278	0.77	BECKIE, 1980
W2 19 18 03 11 SE 801103 MK7			29.5 CONDIE	7.50	142	162	55		2.50	1.56		410	572	134	<4			1479	1024	336	1.05	BECKIE, 1982
W2 19 18 03 12 SW 750212 I.C. 58 1			29.6 CONDIE	7.20	207	60	31	7.0	0.10	0.71		368	477	29	1.3	<0.01	0.20	1380	762	302	0.06	SRC
W2 19 18 03 12 SW 790430 I.C. 58 1			29.6 CONDIE	6.90	203	69	38		<0.1	0.21		371	520	66	<1			1287	876	304	0.89	BECKIE, 1979
W2 19 18 03 12 SW 790600 I.C. 58 1			29.6 CONDIE	6.60	203	96	37		0.40	0.16		349	500	72	2.0			1280	880	286	3.82	BECKIE, 1980
W2 19 18 03 12 SW 800200 I.C. 58 1			29.6 CONDIE	7.20	203	76	45		0.30	0.72		378	510	46	<1			1259	820	310	0.63	BECKIE, 1980
W2 19 18 03 12 SW 801103 MK10(MK11)			29.6 CONDIE	7.70	178	87	49			0.93		412	480	50	<4			1256	808	338	0.04	BECKIE, 1980
W2 19 18 03 12 SW 820720 MK23			26.2 CONDIE	7.90	248	122	52			0.99		376	856	64	3.0			1722	1120	308	2.31	BECKIE, 1982
W2 19 18 03 12 SW 820720 MK24			29.9 CONDIE	7.50	328	141	59			0.99		352	1080	66	<1			2027	1400	288	0.69	BECKIE, 1982
W2 19 18 03 12 SW 820917 MK25			22.3 CONDIE	7.60	240	104	47			0.20		498	552	62	34.0			1537	1038	406	1.40	BECKIE, 1982
W2 19 18 03 12 SW 811217 MK9			25.6 CONDIE	6.00	179	78	43		6.00	0.10		405	460	28	<1			1199	768	332	0.63	BECKIE, 1982

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH M	AQUI- FER	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	PE MG/L	MN MG/L	CO3 MG/L	SD4 MG/L	CL MG/L	NO3 MG/L	PO4 MG/L	F MG/L	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	EDMR BALANCE %	REFERENCE
W2-19-18-03-12-SW	801103	M69	26.5	CONDIE	7.90	128	104	46		1.20		393	476	18	<4				1166	748	322	-0.25	BECKIE, 1980
W2-19-18-03-12-SW	800200	TH1-80	30.5	CONDIE	8.20	160	79	78		1.60	0.88	522	340	100	.0				1282	724	428	1.59	BECKIE, 1980
W2-19-18-03-12-SW	800200	TH1-80	60.0	U.FL.	8.10	166	96	98		1.30	1.18	614	512	16	<1				1504	812	503	1.76	BECKIE, 1980
W2-19-18-03-12-SW	800200	TH1-80	25.9	CONDIE	8.10	158	82	38		1.00	0.88	388	436	32	0.3				1136	734	318	0.19	BECKIE, 1980
W2-19-18-04-02-SW	831000	H8	13.6	CONDIE	7.54	175	75	81	7.1	<0.1	1.20	537	375	20	<4		0.30	1470	1272	745	440	-3.96	REGINA, 1983
W2-19-18-04-03-NW	841012	CAL 306	17.8	CONDIE	7.70	117	52	32	5.9	0.19	0.77	370	216	12	<1	0.09		(1)	806	504	303	3.35	CLIFTON, 1985
W2-19-18-04-03-NW	850509	CAL 306	17.8	CONDIE	7.30	114	52	20	8.0	3.70	0.86	359	220	14	<1			(1)	792	496	294	0.83	CLIFTON, 1985
W2-19-18-04-04-NW	841107	CAL 305	17.7	CONDIE	7.40	98	55	26	5.7	0.16	0.74	383	205	8	<1			(1)	782	472	314	0.37	CLIFTON, 1985
W2-19-18-04-04-NW	850509	CAL 305	17.7	CONDIE	7.20	112	34	20	8.0	0.60	0.88	344	190	6	<1			(1)	715	420	282	1.58	CLIFTON, 1985
W2-19-18-04-05-NW	821006	CAL 102	16.5	CONDIE	7.70	284	128	85	12.0	0.10	1.72	429	960	36	75.3			(1)	2011	1240	352	0.94	CLIFTON, 1985
W2-19-18-04-05-NW	841105	CAL 102	16.5	CONDIE	7.10	221	102	60	8.2	0.10	1.40	379	658	38	18.0	0.07		(1)	1484	972	311	2.31	CLIFTON, 1985
W2-19-18-04-05-NW	850508	CAL 102	16.5	CONDIE	7.60	272	86	44	11.0	0.70	1.60	350	715	34	23.0	0.07		(1)	1537	1024	286	1.98	CLIFTON, 1985
W2-19-18-04-06-SE	821223	M642	21.3	CONDIE	7.70	139	63	90		1.20	0.26	311	456	40	3.0				1112	608	255	0.94	BECKIE, 1982
W2-19-18-04-06-SE	820811	M630	19.5	CONDIE	7.40	224	97	65		0.51		444	608	72	<1				1511	960	364	0.04	BECKIE, 1982
W2-19-18-04-06-SE	820811	M631	15.9	CONDIE	7.40	202	91	41		0.81		444	544	44	<1				1367	880	364	1.26	BECKIE, 1982
W2-19-18-04-06-SE	820811	M632	18.0	CONDIE	7.60	272	116	47		0.72		334	928	28	<1				1726	1156	274	0.94	BECKIE, 1982
W2-19-18-04-06-SE	820811	M633	14.9	CONDIE	7.60	318	118	47		0.04		398	944	34	22.0				1881	1280	326	0.23	BECKIE, 1982
W2-19-18-04-06-SE	821223	M643	15.8	CONDIE	7.80	115	63	59		1.70	0.40	356	328	26	3.0				952	548	292	0.16	BECKIE, 1982
W2-19-18-04-06-SE	820720	M628	30.4	CONDIE	7.90	232	92	48		1.20		419	616	76	<1				1484	960	352	1.40	BECKIE, 1982
W2-19-18-04-06-SE	820811	M629	23.5	CONDIE	7.40	205	111	48		0.50		393	624	60	28.0				1468	968	322	0.22	BECKIE, 1982
W2-19-18-04-11-NW	841107	CAL 309	55.9	U.FL.	7.50	150	99	92	8.2	0.08	1.70	554	520	14	<1	0.30		(1)	1439	784	454	1.15	CLIFTON, 1985
W2-19-18-04-11-NW	850516	CAL 309	55.9	U.FL.	7.19	173	96	92	7.9	2.80	2.60	547	530	12	.0		0.50	1490	1464	826	448	-0.94	CLIFTON, 1985
W2-19-18-04-12-SW	831000	H2	14.9	CONDIE	7.40	179	77	86	6.9	<0.1	1.40	554	400	21	<4		0.35	1620	1326	763	459	-3.11	REGINA, 1983
W2-19-18-05-01-SE	821025	CXRL 009	42.7	U.FL.	7.60	174	88	100	9.0	0.90	1.50	592	512	14	<4			(1)	1491	840	485	0.62	CLIFTON, 1985
W2-19-18-05-01-SW	741002	CXRL 005	44.9	U.FL.	7.81	168	91	92	7.0	1.80	1.47	565	508	7	3.0	<0.05		(1)	1409	760	461	1.79	CLIFTON, 1985
W2-19-18-05-01-SW	821022	CXRL 005	44.9	U.FL.	7.60	168	83	84	8.0	0.70	1.48	562	488	14	<4			(1)	1554	980	316	-0.78	CLIFTON, 1985
W2-19-18-05-02-NW	821013	CAL 109	12.6	CONDIE	7.70	259	81	69	11.0	<0.1	0.58	386	640	94	13.3			(1)	2658	1712	350	0.44	CLIFTON, 1985
W2-19-18-05-02-NW	841105	CAL 109	12.6	CONDIE	7.40	444	146	118	14.0	0.05	0.24	439	1220	244	33.0	0.06		(1)	1483	940	300	1.01	CLIFTON, 1985
W2-19-18-05-02-NW	850508	CAL 109	12.6	CONDIE	7.50	283	56	62	13.0	0.80	0.29	366	553	100	7.0	0.07		(1)	833	484	254	0.61	CLIFTON, 1985
W2-19-18-05-03-SE	820830	CAL 105	13.1	CONDIE	7.80	59	82	40	9.0	13.00	0.10	310	312	8	<4			(1)	1277	844	311	2.02	CLIFTON, 1985
W2-19-18-05-03-SE	841106	CAL 105	13.1	CONDIE	7.20	234	63	36	9.3	1.10	0.70	379	530	24	<1	0.06		(1)	884	484	286	2.38	CLIFTON, 1985
W2-19-18-05-03-SE	850507	CAL 105	13.1	CONDIE	7.70	163	38	24	10.0	2.30	0.81	350	286	10	<1	0.07		(1)	671	400	280	-1.59	CLIFTON, 1985
W2-19-18-05-04-NW	821013	CAL 108	12.2	CONDIE	7.60	101	36	26	6.0	<0.1	0.17	342	152	8	<4			(1)	659	392	280	0.21	CLIFTON, 1985
W2-19-18-05-04-NW	841106	CAL 108	12.2	CONDIE	7.20	86	43	22	6.0	0.08	0.52	342	151	8	<1	0.08		(1)	660	384	270	0.46	CLIFTON, 1985
W2-19-18-05-04-NW	850503	CAL 108	12.2	CONDIE	7.90	114	24	23	7.3	1.80	0.55	329	154	6	<1	0.04		(1)	1525	972	278	2.28	CLIFTON, 1985
W2-19-18-05-04-SE	821022	CAL 106	15.4	CONDIE	7.60	264	76	32	10.0	15.00	0.22	339	704	40	44.3			(1)	1795	1272	267	1.81	CLIFTON, 1985
W2-19-18-05-04-SE	841106	CAL 106	15.4	CONDIE	7.10	339	103	34	9.5	0.09	0.25	326	910	56	17.0	0.06		(1)	1983	1390	282	0.15	CLIFTON, 1985
W2-19-18-05-04-SE	850503	CAL 106	15.4	CONDIE	7.60	378	108	36	14.0	0.30	0.45	320	900	128	18.0			(1)	1364	956	297	4.27	CLIFTON, 1985
W2-19-18-05-07-C	841011	CAL 308	19.5	CONDIE	7.50	221	98	38	7.5	1.20	0.01	362	630	6	<1	0.07		(1)					

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL DEPTH PER M	PH	CA MG/L	MG	NA MG/L	K MG/L	PE MG/L	MM MG/L	CO3 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	P04 MG/L	P MG/L	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	ERROR BALANCE %	REFERENCE
W2-19-18-05-07-C	850507	CAL 308	19.5 CONDIE	7.50	251	76	35	10.0	1.40	1.64	344	660	8	1.0	0.07		(1)	1388	940	282	-2.32	CLIFTON, 1985
W2-19-18-05-07-SE	741002	CORL 006	43.0 U.P.L.	7.21	184	95	86	8.0	0.53	1.96	596	538	7	3.0	<0.05	0.35	1670	1510	849	480	0.30	SRC
W2-19-18-05-13-SE	750212	MCEACHERN	51.2 U.P.L.	7.50	145	92	88	8.0	11.60	0.31	460	534	7	0.2	0.04	0.39	1480	1347	737	377	0.11	SRC
W2-19-18-06-01-SE	850829	MP-1AU	14.1 CONDIE	7.60	163	43	23		0.32		395	325	4	<1				953	584	324	2.62	BECKIE, 1986
W2-19-18-06-01-SE	850829	MP-1AL	18.8 CONDIE	7.60	118	34	20		0.50	0.22	366	194	6	<1			1128	739	436	300	3.30	BECKIE, 1986
W2-19-18-06-01-SE	850829	MP-1B	33.5 U.P.L.	7.20	165	86	92		2.30	1.90	522	480	14	<1				1363	764	428	0.96	BECKIE, 1986
W2-19-18-06-01-SE	800600	REG. R5	49.1 U.P.L.	7.40	157	87	83		0.10	1.65	547	480	10	<1				1366	752	448	1.69	AESI, 1981
W2-19-18-06-01-SE	830728	REG. R5	49.1 U.P.L.	7.40	170	81	87		0.10	1.74	553	468	10	<1				1371	756	453	0.42	CITY OF REGINA
W2-19-18-06-01-SE	840724	REG. R5	49.1 U.P.L.	7.50	170	87	80		0.10	1.86	548	432	12	<1				1331	780	449	2.15	CITY OF REGINA
W2-19-18-06-01-SE	860722	REG. R5	49.1 U.P.L.	7.40	170	83	87		<0.1	1.40	561	450	14	<1				1366	764	480	0.36	CITY OF REGINA
W2-19-18-06-02-NE	850829	MP-2AU	15.8 CONDIE	7.70	237	57	28		5.20	0.65	403	565	10	<1			1063	906	536	308	4.23	BECKIE, 1986
W2-19-18-06-02-NE	850829	MP-2B	17.5 CONDIE	7.30	154	42	15		0.27		376	315	4	<1				1290	672	438	0.68	BECKIE, 1986
W2-19-18-06-02-NE	850829	MP-2B	35.4 U.P.L.	7.70	150	72	105		0.40	1.16	534	415	12	<1				783	472	257	2.08	BECKIE, 1986
W2-19-18-06-02-NE	860303	MP-6AU	16.5 CONDIE	8.00	138	31	21		0.54		350	240	2	<1			825	655	392	248	1.54	BECKIE, 1986
W2-19-18-06-02-NE	860303	MP-6AL	18.3 CONDIE	7.70	110	28	21		0.21	0.54	303	190	2	<1				1649	1136	285	1.29	BECKIE, 1986
W2-19-18-06-02-NE	860303	MP-7AU	16.5 CONDIE	7.00	326	78	30		1.16		348	780	4	82			1303	1189	792	312	-0.31	BECKIE, 1986
W2-19-18-06-02-NE	860303	MP-7AL	18.8 CONDIE	7.60	227	54	24		0.12	0.83	381	500	2	<1				1071	680	275	1.47	BECKIE, 1986
W2-19-18-06-02-NE	860303	MP-8AU	17.1 CONDIE	8.00	190	50	28		0.67		336	460	6	<1			1216	1218	776	318	0.47	BECKIE, 1986
W2-19-18-06-02-NE	860303	MP-8AL	19.2 CONDIE	7.50	216	57	41		0.62	0.93	368	510	4	<1				1346	740	442	0.17	AESI, 1981
W2-19-18-06-02-NE	860600	REG. R6	43.0 N/D	7.10	152	87	92		0.20	1.44	539	460	14	<1				1331	756	446	1.63	CITY OF REGINA
W2-19-18-06-06-NE	830728	REG. R6	43.0 N/D	7.50	160	87	88		0.10	1.52	544	440	10	<1				1262	700	441	-0.56	CITY OF REGINA
W2-19-18-06-06-NE	840724	REG. R6	43.0 N/D	7.50	152	78	83		0.10	1.56	538	396	12	1.0			1304	720	445	-0.29	CITY OF REGINA	
W2-19-18-06-06-NE	860722	REG. R6	43.0 N/D	7.50	165	75	86		<0.1	1.12	543	420	14	<1				657	432	276	1.84	BECKIE, 1986
W2-19-18-06-07-NE	850829	MP-3AU	15.2 CONDIE	7.70	110	38	13		0.33		337	157	2	<1			703	572	368	266	0.14	BECKIE, 1986
W2-19-18-06-07-NE	850829	MP-3AL	20.1 CONDIE	7.60	112	21	5		1.40	0.40	325	107	<2	<1				1556	764	592	2.98	BECKIE, 1986
W2-19-18-06-07-NE	850829	MP-3B	37.5 U.P.L.	7.70	172	81	116		1.40	1.74	722	450	12	<1				886	564	304	0.17	BECKIE, 1986
W2-19-18-06-07-SE	860303	MP-5AU	16.8 CONDIE	8.00	160	40	22		0.62		371	288	4	<1			991	907	580	292	0.30	BECKIE, 1986
W2-19-18-06-07-SE	860303	MP-5AL	18.3 CONDIE	7.60	170	38	20		0.43	0.98	356	320	2	<1				703	476	228	0.95	BECKIE, 1986
W2-19-18-06-08-NE	850829	MP-4AU	14.5 CONDIE	7.80	130	37	10		0.39		278	240	8	<1			642	585	368	266	0.36	BECKIE, 1986
W2-19-18-06-08-NE	850829	MP-4AL	20.1 CONDIE	7.70	96	31	13		0.90	0.49	325	113	6	<1				1464	784	439	1.58	BECKIE, 1986
W2-19-18-06-08-NE	850829	MP-4B	37.5 U.P.L.	7.70	176	84	100		0.80	1.30	536	550	16	<4		0.19	1300	1061	749	280	4.67	REGINA, 1983
W2-19-18-07-09-SE	831000	H5	26.7 CONDIE	7.28	198	62	24	5.9	<0.1	1.40	342	400	28	<4		0.12	1000	900	559	324	2.35	REGINA, 1983
W2-19-18-07-10-NE	831000	H28	28.2 CONDIE	7.67	135	54	16	6.4	<0.1	0.19	395	268	5	<8		0.38	960	853	387	230	4.26	REGINA, 1983
W2-19-18-07-12-NW	831000	H27	29.2 CONDIE	7.57	147	59	21	7.8	<0.1	0.59	344	388	16	<4		0.40	960	952	601	212	0.93	REGINA, 1983
W2-19-18-08-12-SW	831000	H21A	83.4 EMP	7.85	86	42	106	11.0	0.44	0.13	281	300	26	<4		0.48	1270	1389	914	254	3.15	REGINA, 1983
W2-19-18-08-12-SW	831000	H21C	19.5 CONDIE	7.54	155	52	33	12.0	<0.1	0.32	259	430	10	<4				1452	828	461	1.91	BECKIE, 1981
W2-19-18-09-08-SW	831000	H23	18.0 CONDIE	7.32	266	61	43	21.0	0.19	1.00	310	680	6	<4				1537	864	474	1.88	BECKIE, 1981
W2-19-18-10-01-NW	801015	GS 2	47.2 U.P.L.	8.00	134	120	80		1.70	0.36	562	544	10	<1				1537	864	474	1.88	BECKIE, 1981
W2-19-18-10-01-NW	810602	PW2-81	58.5 U.P.L.	7.40	189	95	86		1.90	1.53	578	570	16	<1				1537	864	474	1.88	BECKIE, 1981

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION XX-XX-XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL AQU DEPTH PER IN	PH	CA MG/L	MG	NA	K	PE	MM	CO3	SO4	CL	NO3 -NO3	PO4	P	COND.	SUM OF IONS	T.H. MG/L	T.A. MG/L	ERROR BALANCE %	REFERENCE
W2-19-18-12-07-NE	800600	REG.	BC 38 48.8 N/D	7.60	86	56	45		0.30	0.64		381	228	6	<1			803	448	312	1.39	ASL, 1981
W2-19-18-12-07-NE	800700	REG.	BC 38 48.8 N/D	7.40	102	56	43		0.60	0.48		425	227	2	<1			856	488	348	0.78	ASL, 1981
W2-19-18-12-07-NE	830728	REG.	BC 38 48.8 N/D	7.50	114	57	42		0.60	0.67		436	238	6	<1			894	520	357	0.27	CITY OF REGINA
W2-19-18-12-07-NE	840724	REG.	BC 38 48.8 N/D	7.80	118	58	40		0.60	1.36		433	240	6	<1			897	536	355	0.55	CITY OF REGINA
W2-19-18-12-07-NE	860722	REG.	BC 38 48.8 N/D	7.40	118	59	41		<0.1	0.64		441	248	10	<1			918	540	362	0.59	CITY OF REGINA
W2-19-18-12-07-NW	800600	REG.	BC 166 14.6 N/D	7.40	139	45	10		3.10	0.83		337	264	4	<1			803	532	276	0.27	ASL, 1981
W2-19-18-12-07-NW	860000	REG.	BC 166 14.6 N/D	7.70	152	40	9	4.0	0.90			412	255	4			840	877	545	3.38	3.42 MOLLARD, 1966	
W2-19-18-12-07-NW	800300	REG.	BC 166 14.6 N/D	7.20	147	42	8		15.00	0.88		349	268	2	<1			832	540	286	0.97	CITY OF REGINA
W2-19-18-12-07-NW	800600	REG.	BC 166 14.6 N/D	7.30	104	46	9		4.10	0.12		205	264	2	<1			634	448	168	2.47	ASL, 1981
W2-19-18-12-07-NW	830728	REG.	BC 166 14.6 N/D	7.50	154	43	8		3.30	0.87		298	276	10	<1			793	580	240	2.92	CITY OF REGINA
W2-19-18-12-07-NW	840724	REG.	BC 166 14.6 N/D	7.40	163	41	6		1.20	0.90		338	276	14	<1			840	576	277	0.37	CITY OF REGINA
W2-19-18-12-07-NW	860722	REG.	BC 166 14.6 N/D	7.40	149	42	5		0.50	0.73		335	250	10	<1			792	544	274	0.59	CITY OF REGINA
W2-19-18-12-12-NW	860000	REG.	BC K3 29.9 N/D	7.70	165	77	41		0.20	1.20		517	382	7			1270	1190	727	424	0.83	MOLLARD, 1966
W2-19-18-12-12-NE	800300	REG.	BC K3 29.9 N/D	7.50	160	80	43					514	384	4			1250	1185	730	422	0.29	MOLLARD, 1966
W2-19-18-12-12-NW	800600	REG.	BC K3 29.9 N/D	7.40	176	98	53		0.50			576	456	4				1364	844	472	0.27	CITY OF REGINA
W2-19-18-12-12-NW	800600	REG.	BC K3 29.9 N/D	7.50	165	96	57		0.10	1.52		560	480	6	<1			1366	808	459	1.93	ASL, 1981
W2-19-18-12-12-NW	800600	REG.	BC K3 29.9 N/D	7.60	189	95	59		0.20	1.68		569	526	10	<1			1450	856	466	1.85	ASL, 1981
W2-19-18-12-12-NW	830728	REG.	BC K3 29.9 N/D	7.40	200	119	63		0.10	1.60		599	570	8	<1			1561	868	466	1.35	CITY OF REGINA
W2-19-18-12-12-NW	840724	REG.	BC K3 29.9 N/D	7.40	190	94	57		0.10	1.56		587	472	8	<1			1410	864	481	0.05	CITY OF REGINA
W2-19-18-12-12-NW	860722	REG.	BC K3 29.9 N/D	7.30	190	98	59		<0.1	1.50		595	460	10	<1			1414	860	488	1.25	CITY OF REGINA
W2-19-18-12-13-NW	860000	REG.	BC 2 32.6 N/D	8.10	72	80	44		0.50	0.90		241	370	4			900	812	511	197	1.35	MOLLARD, 1966
W2-19-18-12-13-NW	860000	REG.	BC 2 32.6 N/D	7.30	171	76	41					539	376	4			1250	1207	737	442	0.62	MOLLARD, 1966
W2-19-18-12-13-NW	800600	REG.	BC 2 32.6 N/D	7.30	187	91	71		0.30	1.62		489	560	8	<1			1408	844	401	0.01	ASL, 1981
W2-19-18-12-13-NW	830728	REG.	BC 2 32.6 N/D	7.30	203	109	70		0.30	1.45		624	600	16	<1			1624	956	512	2.27	CITY OF REGINA
W2-19-18-12-13-NW	840724	REG.	BC 2 32.6 N/D	7.70	197	98	64		0.30	1.66		606	530	14	<1			1511	896	497	1.63	CITY OF REGINA
W2-19-18-12-13-NW	860722	REG.	BC 2 32.6 N/D	7.20	200	102	70		<0.1	1.48		614	520	14	<1			1521	920	503	0.31	CITY OF REGINA
W2-19-18-12-16-NE	860500	D8-86	68.7 N/D	8.20	141	79	58		1.40	0.06		517	350	2	<1			1148	676	424	0.75	BECKIE, 1986
W2-19-18-13-02-SE	800600	REG.	BC 4 42.7 N/D	7.40	136	68	36		0.40	1.24		467	320	8				1037	620	383	2.09	ASL, 1981
W2-19-18-13-02-SE	800700	REG.	BC 4 42.7 N/D	7.50	122	72	39		0.30	1.12		409	320	4				967	600	330	0.84	ASL, 1981
W2-19-18-13-02-SE	830728	REG.	BC 4 42.7 N/D	7.40	141	74	39		0.40	1.08		475	292	10	<1			1032	656	389	2.32	CITY OF REGINA
W2-19-18-13-02-SE	840724	REG.	BC 4 42.7 N/D	7.70	146	69	34		0.40	1.10		472	300	6	<1			1029	648	387	1.01	CITY OF REGINA
W2-19-18-13-02-SE	860722	REG.	BC 4 42.7 N/D	7.50	136	65	34		<0.1	0.90		464	278	8	<1			986	608	381	0.02	CITY OF REGINA
W2-19-18-13-02-SE	860000	REG.	BC 191 43.9 N/D	7.50	137	63	34	6.0				461	282	4				987	600	378	0.41	MOLLARD, 1966
W2-19-18-13-02-SE	860000	REG.	BC 191 43.9 N/D	130	57	41	6.0		1.70	0.70		438	252	4				930	559	359	2.24	MOLLARD, 1966
W2-19-18-13-05-SE	800600	REG.	BC 192 32.3 N/D	7.60	186	112	63		0.10	0.66		622	530	4	<1			1518	924	510	0.25	ASL, 1981
W2-19-18-13-05-SE	830728	REG.	BC 192 32.3 N/D	7.20	211	108	69		0.80	1.74		637	560	14	<1			1602	972	522	0.18	CITY OF REGINA
W2-19-18-13-05-SE	840724	REG.	BC 192 32.3 N/D	7.40	211	110	65		0.70	1.60		632	560	14	<1			1594	980	518	0.02	CITY OF REGINA
W2-19-18-13-05-SE	860722	REG.	BC 192 32.3 N/D	7.40	205	108	69		<0.1	1.52		650	525	12	<1			1571	956	533	0.44	CITY OF REGINA
W2-19-18-24-02-SE	750210	KING	33.5 U.P.L.	7.20	198	94	50	7.0	6.30	1.56		601	484	3	<0.1	<0.01	0.40	1520	882	493	0.17	SAC

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION XX XX-XX-XX-XX-XX-XX	DATE MM-YY-YY	WELL NAME	WELL DEPTH M	AQUI- FER	PH	CA MG/L	MG	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	PO4 MG/L	P MG/L	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	FORUM BALANCE %	REFERENCE
M2-19-18-24-02-SE	861103	KING	33.5	U.P.L.	7.24	203	86	52	7.0	1.6	1.7	580	483	5	<0.02	<0.03	0.28	1530	1420	859	475	0.18	SRC
M2-19-18-25-16-NE	861103	BINER	54.6	N/D	7.44	146	30	132	11.0	0.52	0.21	455	384	29	<0.02	0.03	0.23	1370	1188	486	373	1.58	SRC
M2-19-18-36-04-SE	861106	JUNISON	34.7	U.P.L.	7.26	296	80	47	8.8	1.10	1.90	543	689	21	<0.02	<0.03	0.28	1790	1688	1070	445	0.49	SRC
M2-19-19-08-15-NW	750211	PAUK	15.5	N/D	7.10	154	63	127	10.0	0.22	0.67	531	483	<1	<0.1	0.02	0.43	1450	1369	644	435	0.36	SRC
M2-19-19-31-12-SW	860000	REG. M2	26.3	L.P.L.	7.60	143	78	59		1.00	1.00	550	350	8				1200	1189	678	451	1.25	MOLLARD, 1966
M2-19-19-31-12-SW	800300	REG. M2	26.3	L.P.L.	7.60	117	75	51		0.20	1.26	510	262	4					1020	600	418	1.06	CITY OF REGINA
M2-19-19-31-12-SW	800600	REG. M2	26.3	L.P.L.	7.40	120	78	51			1.01	495	292	4	<1				1041	620	406	1.10	ASL, 1981
M2-19-19-31-12-SW	800700	REG. M2	26.3	L.P.L.	7.50	122	80	42		0.90	1.16	489	300	10	<1				1052	624	401	0.70	ASL, 1981
M2-19-19-31-12-SW	800300	REG. M3A	33.7	L.P.L.	7.20	122	80	42		<0.1	1.26	483	284	6	<1				1018	632	396	1.74	CITY OF REGINA
M2-19-19-31-12-SW	800600	REG. M3A	33.7	L.P.L.	7.20	131	78	46		<0.1	1.06	460	320	10	<1				1046	648	377	1.60	ASL, 1981
M2-19-19-31-12-SW	830728	REG. M3A	33.7	L.P.L.	7.40	126	68	45		<0.1	1.14	481	284	12	<1				1017	596	394	1.06	CITY OF REGINA
M2-19-19-31-12-SW	840724	REG. M3A	33.7	L.P.L.	7.70	130	76	45		0.30	1.24	492	280	10	<1				1035	636	403	1.80	CITY OF REGINA
M2-19-19-31-12-SW	860722	REG. M3A	33.7	L.P.L.	7.50	117	66	42		<0.1	0.98	495	242	10	<1			1300	973	564	383	1.28	CITY OF REGINA
M2-19-19-31-12-SW	660000	REG. M4	28.7	L.P.L.	7.50	158	81	55	8.0	1.70		525	396	13					1238	727	431	0.21	MOLLARD, 1966
M2-19-19-31-12-SW	800600	REG. M4	28.7	L.P.L.	7.40	181	106	66		0.70	1.12	571	506	14	<1				1446	888	488	0.82	ASL, 1981
M2-19-19-31-12-SW	800600	REG. M4	28.7	L.P.L.	7.30	195	110	75		0.30	2.30	622	560	28	5.0				1598	940	510	1.52	ASL, 1981
M2-19-19-31-12-SW	830728	REG. M4	28.7	L.P.L.	7.40	170	90	63		1.62		558	440	12	<1				1335	796	457	0.05	CITY OF REGINA
M2-19-19-31-12-SW	840724	REG. M4	28.7	L.P.L.	7.50	158	96	70		1.00	0.58	538	440	10	<1				1314	792	441	1.52	CITY OF REGINA
M2-19-19-31-12-SW	860722	REG. M4	45.1	L.P.L.	7.60	155	86	59		<0.1	1.44	565	390	14	<1			1580	1484	903	455	1.74	MOLLARD, 1966
M2-19-19-31-13-NW	660000	REG. 14A	45.1	L.P.L.	7.70	190	104	73	8.0		1.10	555	543	10				1600	1545	915	556	0.89	MOLLARD, 1966
M2-19-19-31-13-NW	800300	REG. 14A	45.1	L.P.L.	7.60	193	106	70	8.0	5.80	0.81	678	480	4	<1				1527	896	574	0.02	CITY OF REGINA
M2-19-19-31-13-NW	800600	REG. 14A	45.1	L.P.L.	7.30	200	96	72		3.80	0.81	700	444	10	<1				1321	880	546	0.65	ASL, 1981
M2-19-19-31-13-NW	800600	REG. 14A	45.1	L.P.L.	7.40	184	102	76		3.60	1.44	666	478	10	<1				1555	936	550	0.97	CITY OF REGINA
M2-19-19-31-13-NW	830728	REG. 14A	45.1	L.P.L.	7.40	198	107	75		1.10	0.83	671	492	10	<1				1470	872	535	0.25	CITY OF REGINA
M2-19-19-31-13-NW	840724	REG. 14A	45.1	L.P.L.	7.30	186	99	70		1.20	0.82	653	448	12	<1				1326	896	551	1.04	CITY OF REGINA
M2-19-19-31-13-NW	860722	REG. 14A	45.1	L.P.L.	7.50	181	108	70		0.60	0.66	672	480	14	<1				1439	844	530	0.75	CITY OF REGINA
M2-19-19-31-13-NW	800300	REG. M1	42.1	L.P.L.	7.30	170	102	75		3.00	0.75	648	436	6	<1				1392	864	492	1.09	ASL, 1981
M2-19-19-31-13-NW	800600	REG. M1	42.1	L.P.L.	7.10	168	92	70		2.70	1.44	600	452	6	<1				1449	864	498	0.49	ASL, 1981
M2-19-19-31-13-NW	800700	REG. M1	42.1	L.P.L.	7.10	166	109	66		2.50	0.80	608	488	4	5.0				1580	925	560	0.35	MOLLARD, 1967b
M2-19-19-31-14-NE	670423	REG. P2	49.1	L.P.L.	7.17	190	109	73	9.0			682	508	9					1570	912	561	0.83	MOLLARD, 1967b
M2-19-19-31-14-NE	670424	REG. P2	49.1	L.P.L.	7.12	198	101	70	8.0	3.37	1.00	684	495	10					1517	872	547	1.45	ASL, 1981
M2-19-19-31-14-NE	800300	REG. P2	49.1	L.P.L.	7.40	176	105	74		1.60	0.78	666	488	6	<1				1508	876	538	2.24	ASL, 1981
M2-19-19-31-14-NE	800600	REG. P2	49.1	L.P.L.	7.30	185	113	66		3.50	0.71	656	492	12	<1				1535	904	554	0.44	CITY OF REGINA
M2-19-19-31-14-NE	830728	REG. P2	49.1	L.P.L.	7.40	190	104	72		2.70	0.76	676	480	10	<1				1486	952	547	4.18	CITY OF REGINA
M2-19-19-31-14-NE	860722	REG. P2	49.1	L.P.L.	7.20	194	114	67		1.00	0.87	667	432	10	<1				1528	900	558	0.54	CITY OF REGINA
M2-19-19-31-14-NE	860722	REG. P2	49.1	L.P.L.	7.30	174	113	71		0.70	0.75	707	450	12	<1				1770	770	490	0.80	SRC
M2-19-20-05-04-NE	750211	NEULS	49.4	L.P.L.	7.22	162	89	61	8.0	6.00	2.48	598	410	7	<0.1	<0.01	0.45	1430	1344	770	490	0.80	SRC
M2-19-20-05-08-SE	750211	DAVIES	65.2	L.P.L.	7.22	198	105	70	20.0	4.10	10.30	764	466	13	0.2	<0.01	0.35	1690	1651	927	627	1.20	SRC
M2-19-20-06-02-SW	750211	MAJNER	32.3	L.P.L.	7.08	187	105	73	7.0	14.10	0.86	682	488	7	0.3	0.03	0.40	1550	1565	899	559	0.56	SRC

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGION A (CONTINUED)

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION	DATE	WELL NAME	WELL DEPTH PER M	PHI	CA	MG/L	NA	K	FE	MN	CUS	HCL3	SO4	CL	NO3 -NO3	P04	F	COND.	SUM OF IONS	T.H.	T.A.	ERROR BALANCE	REFERENCE
XX XX XX XX XX XX YYMMDD					MC/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	US/CM	ME/L	ME/L	%		
W2 20 17 33 16 NE 800700 REG. W1			49.1 U.P.L.	7.40	152	113	91		2.00	1.15		588	512	14					1473	844	482	-0.35 AESI., 1991	
W2 20 17 33 16 NE 830728 REG. W1			49.1 U.P.L.	7.60	178	85	98		1.10	1.28		595	496	14	<1				1468	792	488	0.83 CITY OF REGINA	
W2 20 17 33 16 NE 840724 REG. W1			49.1 U.P.L.	7.40	165	89	94		2.90	1.20		589	416	14	<1				1371	780	483	2.44 CITY OF REGINA	
W2 20 17 33 16 NE 860722 REG. W1			49.1 U.P.L.	7.50	141	104	96		0.90	1.04		600	465	18	<1				1426	780	492	0.64 CITY OF REGINA	
W2 20 17 35-13 NW 800600 REG. R4			40.8 U.P.L.	7.10	163	92	94		0.90	1.28		565	484	10	<1				1410	788	462	0.43 AESI., 1981	
W2 20 17 35-13 NW 830728 REG. R4			40.8 U.P.L.	7.50	170	92	92		1.00	1.34		582	496	10	<1				1444	804	477	0.24 CITY OF REGINA	
W2 20 17 36-03 SW 800600 REG. K7			31.7 U.P.L.	7.50	142	86	106		0.40	1.56		526	480	14	<1				1356	708	431	0.63 AESI., 1981	
W2 20 17 36-03 SW 830728 REG. K7			31.7 U.P.L.	7.50	160	87	88		0.10	1.52		544	440	10	<1				1331	756	446	1.63 CITY OF REGINA	
W2 20 17 36-03 SW 840724 REG. K7			31.7 U.P.L.	7.50	147	92	97		0.20	0.98		531	456	18	<1				1342	748	435	1.11 CITY OF REGINA	
W2 20 17 36-03 SW 860722 REG. K7			31.7 U.P.L.	7.50	149	85	102		1.30	0.90		545	450	16	<1				1349	720	447	0.30 CITY OF REGINA	
W2 20 18-04-09 NW 860722 REG. W5			50.8 U.P.L.	7.50	136	80	100		1.20	0.49		592	380	14	<1		0.03	0.42	12.30	1304	668	0.82 CITY OF REGINA	
W2 20 18-08-09 NE 750211 HABLE			33.8 U.P.L.	7.36	132	67	65		7.0	2.80	1.39	476	360	1	0.2				1113	603	390	0.81 SRC	
W2 20 18-10-09 NW 831000 H13A			42.3 U.P.L.	7.47	125	61	73		6.5	<0.1	1.10	476	265	13	<4		0.30	12.20	1021	563	390	3.17 REGINA, 1983	
W2 20 18-10-09 NW 831000 H13R			19.8 CONDIE	7.48	146	53	66		8.9	<0.1	1.10	383	320	14	<4		0.41	12.30	1002	582	322	4.33 REGINA, 1983	
W2 20 18-10-11 NW 831000 H24A			29.7 U.P.L.	7.54	101	56	47		15.0	0.37	0.29	383	230	9	<4		0.58	9.00	842	482	314	3.09 REGINA, 1983	
W2 20 18-11-11 NE 831000 H22			24.4 CONDIE	7.38	95	34	26		11.0	0.33	0.40	339	138	5	<4		0.45	6.90	649	377	278	2.03 REGINA, 1983	
W2 20 18-12-10 NW 831000 H26			27.3 CONDIE	7.71	169	82	79		12.0	<0.1	1.50	516	463	18	<4		0.27	14.60	1341	759	423	-0.81 REGINA, 1983	
W2 20 18-12-16 NW 800300 REG. R2			35.4 CONDIE	7.40	181	75	24		0.60	0.82		354	440	26	<1				1101	760	290	1.72 CITY OF REGINA	
W2 20 18-12-16 NW 800600 REG. R2			35.4 CONDIE	7.20	176	73	25		0.50	1.56		338	462	30	<1				1106	740	277	0.41 AESI., 1981	
W2 20 18-12-16 NW 830728 REG. R2			35.4 CONDIE	7.40	210	77	25		0.50	0.86		355	512	60	<1		0.75	12.40	1240	840	291	0.75 CITY OF REGINA	
W2 20 18-12-16 NW 840724 REG. R2			35.4 CONDIE	7.30	206	81	23		0.30	0.88		351	476	64	<1				1202	848	288	-1.34 CITY OF REGINA	
W2 20 18-12-16 NW 860722 REG. R2			35.4 CONDIE	7.60	237	87	25		<0.1	0.90		371	530	106	<1				1357	952	304	0.08 CITY OF REGINA	
W2 20 18-13-06 SE 750211 IPS. 67.1			60.4 U.P.L.	7.53	114	58	4		5.0	11.80	0.90	278	308	4	2.0		0.04	0.27	904	786	522	1.68 SRC	
W2 20 18-15-12 NW 780218 SRC R.530			38.3 U.P.L.	7.64	91	34	13		4.2	0.27	0.60	314	128	5	-0		0.05	0.16	668	591	367	-0.26 SRC	
W2 20 18-15-12 NW 830831 SRC R.530			38.3 U.P.L.	7.74	90	31	12		4.1	0.43	0.55	292	112	14	<0.2	<0.03	0.10	661	556	351	239	-0.99 SRC	
W2 20 18-15-16 SE 871014 MURAN			48.7 U.P.L.	7.61	172	62	69		6.9	3.20	0.99	427	452	11	0.03	<0.03		1200	1204	683	350	0.42 SRC	
W2 20 18-19-01 NE 750212 PROHER			51.2 U.P.L.	7.30	138	60	64		7.0	3.00	0.97	456	361	<1	0.1	0.03	0.40	1240	1091	591	374	0.77 SRC	
W2 20 18-22-08 SE 750211 MEDDICAL			60.4 N/D	7.37	227	96	327		11.0	1.13	0.21	617	1122	42	1.2	0.06	0.38	2490	2445	963	506	1.42 SRC	
W2 20 18-22-08 SE 871014 MEDDICAL			61.6 N/D	7.50	233	108	294		11	4.40	0.19	603	1150	38	0.04	0.06	0.46	2660	2442	1030	494	1.93 SRC	
W2 20 18-24-01 SE 750212 HUTKIN			57.6 N/D	7.05	122	62	59		6.0	1.60	1.23	455	310	<1	1.2	0.02		1180	1019	556	373	0.17 SRC	
W2 20 18-32-13 SW 871022 COND. JULY				7.85	384	170	176		9.8			374	1490	112				2930	2716	1660	306	-0.91 SRC	
W2 20 18-32-15 NW 871013 MCLAND				7.63	267	122	115		9	0.59	0.70	486	940	35	1.7	<0.03		2120	1977	1170	398	-0.07 SRC	
W2 20 19-06-07 - N 571022 GOLF SPR.			25.6 U.P.L.	8.23	83	63	71		6.9			290	354	9.3				1030	877	466	237	-0.81 SRC	
W2 29 19-06-13 SW 871022 TROUT POND				8.17	99	66	77		6.8			338	370	10				1140	967	517	278	-1.34 SRC	
W2 20 19-23- NW			26.2 N/D		192	92	112					862	347	23					1628	858	707	-0.04 RUTHERFORD, 1966	
W2 20 20-13- NW			25.3 N/D	7.10	180	70	41		5.0			520	410	11	17.0				1254	738	426	2.89 RUTHERFORD, 1966	
W2 20 20-16-02 SE 750211 SMALL			131.7 EMP	7.49	106	47	611		8.0	7.76	0.19	633	1046	140	0.7	<0.31	0.35	2910	2600	457	519	0.27 SRC	
W2 20 20-22-06 NE 750211 CATLEY			132.3 EMP	7.45	123	54	445		8.0	9.19	0.28	625	878	87	1.3	<0.2	0.35	2520	2231	531	512	1.43 SRC	
W2 20 20-24- SE			45.7 N/D	7.60	174	95	37		6.0			838	365	8	9.0				1332	926	523	0.45 RUTHERFORD, 1966	

TABLE D-1 LIST OF WATER QUALITY DATA FOR REGINA AREA (CONTINUED)

LAND LOCATION XX XX XX-XX-XX-XX	DATE YYMMDD	WELL NAME	WELL ACQ- DEPTH PER M	PH	CA MG/L	MG MG/L	NA MG/L	K MG/L	FE MG/L	MN MG/L	CO3 MG/L	SO4 MG/L	CL MG/L	NO3 -NO3 MG/L	P04 MG/L	P MG/L	COND. US/CM	SUM OF IONS MG/L	T.H. MG/L	T.A. MG/L	ERROR BALANCE %	REFERENCE	
W2-20-20-26--SE			13.7 N/D	7.60	214	224	107	10.0				564	349	294	528.0			2291	1457	462	-1.01	RUTHERFORD, 1966	
W2-20-20-27-04	750212	RODEN	127.4 EXP	7.32	120	53	251	8.0	20.10	0.65		633	493	38	<0.1	0.09	0.30	1690	1617	515	0.60	SR	
W2-21-15-10-15-NW	750212	HOODER	71.9 L.F.L.	7.23	142	73	293	7.0	0.27	0.67		727	596	70	0.2	0.02	0.35	2010	1910	655	0.58	SR	
W2-21-15-32-SE			46.9 N/D		155	100	499					1037	857	113				2761	798	850	0.47	RUTHERFORD, 1966	
W2-21-16-02-01-SW	871014	GANSBURN	37.5 U.P.L.	7.45	201	121	468	10	1.00	0.84		654	1220	109	<0.02	<0.03		3150	2785	997	536	-1.76	SR
W2-21-16-10--NW			24.4 N/D		143	91	307					604	816	39				2000	733	495	0.02	RUTHERFORD, 1966	
W2-21-16-12-13-NW	871014	SELRV	53.6 U.P.L.	7.63	153	79	288	7.6	0.28	0.90		623	707	46	0.09	0.12	2190	1905	708	511	-1.17	SR	
W2-21-16-14--SW			64.6 U.P.L.		122	95	239					622	623	40				1741	696	510	-0.01	RUTHERFORD, 1966	
W2-21-16-24-04-SW	871015	HAKIL	29.0 U.P.L.	7.35	374	125	196	11	0.32	1.80		642	1270	34	<0.02	<0.03	2700	2654	1140	527	0.22	SR	
W2-21-16-36-08-SE	871014	GANSBURN	30.2 U.P.L.	7.69	158	114	168	9.4	0.35	0.65		602	681	20	0.04	0.15	1910	1754	861	494	0.40	SR	
W2-21-17-02--NW			12.2 N/D	7.90	141	108	164	6.0				634	558	23	6.0			1640	797	520	0.99	RUTHERFORD, 1966	
W2-21-17-14-06-SE	750213	FARLEY	47.9 U.P.L.	7.31	109	51	279	8.0	5.00	0.11		582	564	7	6.1	0.03	0.38	1780	1612	482	477	0.87	SR
W2-21-17-22-SE			19.8 N/D	8.00	183	80	176	8.0				665	620	35				1767	787	545	2.53	RUTHERFORD, 1966	
W2-21-17-27-02-SE	871015	LIPSETT	37.8 U.P.L.	7.61	140	76	212	8	4.10	0.09		527	574	42	0.02	0.12	1830	1583	653	432	2.00	SR	
W2-21-17-32--SW			36.6 N/D	8.34	49	32	117	12.0			12	231	255	48				756	254	205	1.76	RUTHERFORD, 1966	
W2-21-18-02-12-NW	871014	DELAARIE	26.5 N/D	7.52	181	97	137	9.2	2.50	0.42		556	661	17	0.04	0.06	1760	1661	847	455	0.32	SR	
W2-21-18-14-14-NE	730330	MARTIN	66.1 N/D	7.23	171	75	185	9.4	5.90			540	660	21	<1	<0.1	0.26	1680	1668	737	442	0.45	SR
W2-21-18-26-02-SW	750211	ENGLISH	17.7 CONDIE	7.28	492	342	167	17.0	0.74	0.03		314	2399	67	159.0	0.02	0.44	3860	3958	2630	257	-0.68	SR
W2-21-18-36-14-NW	871013	PETERS	41.1 U.P.L.	7.70	136	84	92	6.7	1.10	0.77		505	431	10	0.09	0.06	1420	1267	686	414	0.94	SR	
W2-21-19-33-SE			6.1 N/D		185	75	68					462	510	5				1305	770	379	-0.08	RUTHERFORD, 1966	
W2-21-19-33-SW			45.7 N/D		479	194	79					1971	374	114				3211	1986	1615	0.01	RUTHERFORD, 1966	

TABLE D-2 SELECTED WATER QUALITY DATA FROM LISSEY (1962)

LAND LOCATION	WELL NAME	DEPTH M	PH	CA MG/L	MG MG/L	NA+K MG/L	FE MG/L	CO3 MG/L	HCO3 MG/L	SO4 MG/L	CL MG/L	NO3 MG/L	F MG/L	TDS MG/L	T.H MG/L	TOT. ALK. MG/L	PHEN. ALK. MG/L
W2-17-18-03-	SW BALGONIE	5.8	8.8	115	53	NIL	NIL	9	468	63	25	58	0.0	506	506	398	7
W2-18-10-10-	SE FARM	6.1	8.8	126	67	25	0.07	13	396	278	18	NIL	0.36	764	590	338	11
W2-18-17-12-	SW FARM	7.6	8.6	438	123	210	1.60	9	468	1480	95	1.20	NIL	2689	1600	398	7
W2-18-17-22-	NW FARM	6.1	8.7	192	80	32	0.07	13	274	537	17	NIL	0.10	1020	810	247	11
W2-18-17-23-	NE PILOT BUTTE	9.1	8.7	137	40	NA	0.11	13	231	223	27	55.00	0.32	671	507	212	11
W2-18-17-23-	SE GROC.	4.3	7.8	57	76	NA	0.08	NIL	551	NA	NA	4.55	NA	880	452	452	NIL
W2-18-17-30-	NW FARM	6.1	8.8	186	87	38	0.14	22	358	510	29	84.00	0.10	1144	822	330	18
W2-18-18-06	SE FARM	10.7	8.4	126	47	NIL	NIL	13	234	198	36	38	0.32	651	507	214	11
W2-18-18-07	NW TH#2-B161	55.8	8.2	156	84	NA	0.45	5	688	240	15	0.70	0.05	990	735	572	4
W2-18-18-12	SE FARM	15.2	8.4	142	63	81	5.10	13	495	305	30	NIL	0.42	907	616	428	11
W2-18-18-22-	SE FARM	22.9	8.4	82	33	NIL	0.44	13	234	69	13	7.20	0.28	430	343	214	11
W2-19-16-22-	NW FARM	12.2	8.5	154	67	435	2.30	30	470	1012	78	4.10	NIL	2112	658	436	25
W2-19-16-33-	NE TH10-BR60	16.8	7.6	134	85	NA	0.50	NIL	671	NA	NA	1.42	NA	1980	685	550	NIL
W2-19-17-24-	SW FARM	13.7	7.8	142	63	97	0.99	NIL	390	435	21	NIL	0.1	1088	616	320	NIL
W2-19-17-25-	NW K1	42.4	8.2	119	56	51	0.12	NIL	438	261	5	1.60	0.30	742	520	359	NIL
W2-19-17-32-	SW TOR	30.5	7.2	176	107	NA	1.80	NIL	488	NA	NA	4.40	NA	1250	835	400	NIL
W2-19-18-03-	SE TH#2-BR60	52.1	7.6	67	48	NA	NIL	NIL	56	NA	NA	0.26	NA	2100	364	46	NIL
W2-19-18-05-	SW CO-OP #6	42.1	7.0	184	124	NA	0.60	NIL	573	NA	NA	NIL	NA	1260	970	470	NIL
W2-19-18-12-	NE TH#1-B161	46.3	7.7	206	105	NA	1.28	NIL	479	400	15	NIL	NIL	1160	945	393	NIL
W2-19-18-12-	NW TH#1-H61	33.5	7.6	117	170	NA	4.10	NIL	612	251	10	NA	NIL	1025	990	502	NIL
W2-19-18-12-	NW TH#2-H61	45.7	7.4	126	42	150	0.16	NIL	529	368	10	NIL	NIL	1006	485	434	NIL
W2-19-19-31-	NW PW#9G	35.1	7.2	129	76	NA	0.14	NIL	580	NA	NA	3.05	NA	900	632	476	NIL
W2-20-17-13-	NE TH#7-BR60	20.4	8.2	129	130	NA	0.80	50	437	NA	NA	NIL	NA	960	855	442	41
W2-20-17-21-	SW W.CLAY	45.7	7.2	164	115	NA	2.00	NIL	524	NA	NA	NIL	NA	1220	880	430	NIL
W2-20-17-22-	NE RCOMP	54.9	7.4	324	363	NA	0.60	NIL	530	NA	NA	NIL	NA	2800	435	NIL	NIL
W2-20-17-24-	NW EXHIB.	59.4	7.6	73	51	NA	0.40	NIL	66	NA	NA	2.10	NA	1400	392	54	NIL
W2-20-17-24-	NW TH#1-P61	55.9	7.4	161	142	NA	1.10	NIL	751	NA	NA	NIL	0.75	970	985	616	NIL
W2-20-17-26-	NW TH#8-BR60	61.0	7.5	146	96	NA	12.00	NIL	600	NA	NA	0.70	NA	1200	756	492	NIL
W2-20-17-27-	NW TH#4-H61	52.7	7.6	122	49	226	3.80	NIL	589	445	26	NIL	NIL	1235	505	483	NIL
W2-20-17-34-	NW TH#3-H61	46.3	7.7	97	81	186	1.70	NIL	510	505	28	NIL	0.26	1139	576	418	NIL
W2-20-17-35-	NW PW#R3	40.5	8.4	234	65	NA	1.76	5	384	510	NIL	NIL	NA	1220	850	323	4
W2-20-18-08-	NE TH#9-BR60	42.7	7.5	157	161	NA	0.71	NIL	594	NA	NA	2.21	NA	1250	1050	437	NIL
W2-20-18-12-	NW PW#R2	35.4	7.9	101	54	115	0.04	NIL	396	348	16	NIL	0.15	915	475	325	NIL
W2-20-20-28-	SW TH16-BR60	63.1	7.0	146	85	NA	2.80	NIL	594	NA	NA	0.72	NA	2240	714	487	NIL
W2-20-20-33-	SE TH3-MT29	39.6	NA	160	123	NA	10.00	NIL	488	780	188	NA	NA	2160	905	400	NIL
W2-20-20-34	SW TH2-MT29	51.2	NA	220	133	NA	10.00	NIL	695	494	89	NA	NA	1660	1096	695	NIL
W2-21-20-20-	NE TH17-BR60	69.5	7.2	118	75	NA	0.16	NIL	637	NA	NA	0.88	NA	1720	602	522	NIL

NOTE: NA MEANS NOT AVAILABLE

NIL MEANS NOT DETECTABLE

CALCIUM AND MAGNESIUM DATA CALCULATED FROM HARDNESS DATA PROVIDED BY LISSEY (1962)
BICARBONATE AND CARBONATE DATA CALCULATED FROM ALKALINITY DATA PROVIDED BY LISSEY (1962)